Model 3300A

FUNCTION GENERATOR

Serials Prefixed: 519

-hp- Part No. 03300-90000

OPERATING AND SERVICE MANUAL

PRELIMINARY

OPERATING AND SERVICE MANUAL

-hp- Part No. 03300-90000

Model 3300A

FUNCTION GENERATOR

Serials Prefixed: 519

P. O. Box 301, Loveland, Colorado, 80537 U. S. A.

HEWLETT hp PACKARD

FUNCTION GENERATOR

model
3300A
3301A
3302A
Plug-In Units

TENTATIVE DATA 8 MAR 65

FEATURES

—Sine, square, triangular waves
—Range 0.01 to 100 kc
—High stability
—Flat frequency response
—Distortion less than 1%
—Plug-in capability
—Electronic frquency control
—Balanced, single ended, and floating output
—Two ouput amplifiers

USES

—Vibration studies
—Servo applications
—Medical research
—Geophysical problems
—Subsonic, audio testing
—Frequency response measurements

DESCRIPTION

Maximum versatility and usefulness with plug-ins and multiple outputs set the hp 3300A Function Generator apart from other function generators. Any two of three waveforms—sine, square, or triangular—may be selected by a front panel switch, covering all frequencies from 0.01 cps to 100 kc, continuously variable in seven decade ranges. This solid-state, multi-purpose source provides simultaneous signals of any two waveforms, with constant amplitude over the entire frequency range.

Plug-ins, which insert directly into the front panel include the hp 3301A Auxiliary Plug-in, and hp 3302A Trigger Phase Lock Plug-in. The 3302A Plug-in provides single and multiple cycle operation with variable start/stop phase. A phase lock loop in the 3302A permits synchronyzing the 3300A with an external signal and provides variable phase control. The hp 3300A Function Generator with plug-in versatility provides a compact, convenient, multi-purpose source of test waveforms useful for testing servo, geophysical and medical equipment, and for the electrical simulation of mechanical phenomena.

ELECTRONIC FREQUENCY CONTROL

The frequency of the hp 3300A can be controlled by either the front panel frequency dial or an external voltage applied to a rear terminal connector. This feature is useful for sweeping filters, amplifiers and other frequency dependent devices and for externally programming frequencies for production testing. An input voltage of —0.5 to —10 volts will linearly control the frequency over any one range.

OUTPUT SYSTEM

The output system of the hp 3300A is dc coupled and fully floating with respect to power line ground. An internal shield reduces radiated interference and provides common mode rejection with floating output. Separate connectors on the rear panel provide terminals for circuit ground, shield ground, and power line ground. The operator may connect a dc supply to the rear terminals and obtain any dc offset voltage on the output up to ±500 volts with respect to power line ground.

The 3300A may be used to supply a balanced output, using both output amplifiers. Each output amplifier will deliver 35 volts p-p into an open circuit.

This instrument is rugged, and is constructed with quality components. It is simple to operate, and it is adaptable to a wide variety of low-frequency field or laboratory work.

P. O. Box 301, Loveland, Colorado, 80537, Tel. (303) 667-5000
Europe: 54 Route Des Acacias, Geneva, Switzerland, Cable: "HEWPACKSA" Tel. (022) 42.81.50

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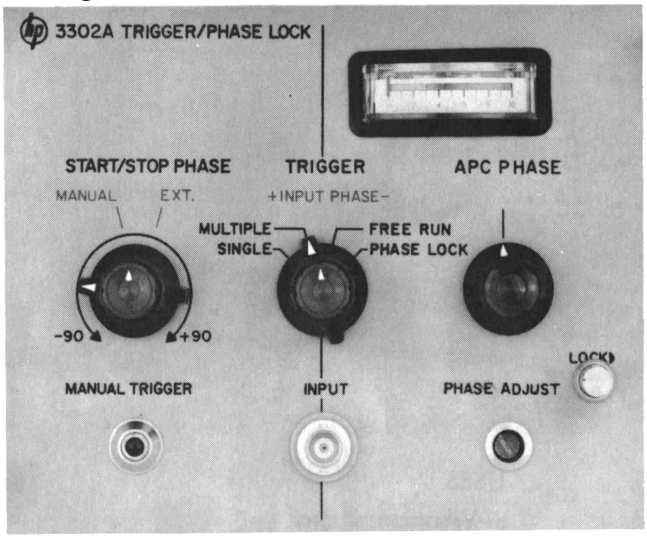
3301A AUXILIARY PLUG-IN

The 3301A Auxiliary Plug-in provides internal connections for basic unit operation.

3302A TRIGGER/PHASE LOCK PLUG-IN

The 3302A Trigger/Phase Lock Plug-in is designed to provide single cycle, multiple cycle, and phase lock operation. The instrument can be triggered over the entire frequency range, either manually or by applying an external voltage.



SINGLE CYCLE OPERATION

In single cycle operation, one cycle of any function can be obtained by pushing the manual trigger or applying a voltage to the external trigger input. The output starts and stops at the same phase, which is adjustable from —90 degrees to +90 degrees with the front panel start/stop phase control. The input trigger circuit is DC coupled and can be actuated with either polarity of applied voltage.

In the single cycle mode, a variable phase output can be obtained by triggering with an external sine wave tuned to the same frequency as the 3300A, using the input phase switch and the start/stop phase control. This is particularly useful at frequencies below 10 cps where a phase lock system is not practical.

In addition, when an external trigger is applied, the instrument can be used as a low frequency pulse generator using the square wave output. The pulse repetition rate is determined by the repetition rate of the applied trigger voltage; the pulse width is controlled by the 3300A frequency control; and the pulse delay is adjustable using the start/stop phase control. Pulses can also be obtained by using the manual trigger.

MULTIPLE CYCLE OPERATION

In the multiple cycle mode of operation, any number of complete cycles of any function can be obtained by pushing the manual trigger to start and stop, or by applying an external gate voltage. The output signal will start and stop at the same phase, which is adjustable from —90 to +90 degrees with the start/stop phase control. The 3302A is useful for generating waveform bursts or pulse trains for transient response and coding system measurements.

PHASE LOCK OPERATION

The 3300A may be phase-locked to any periodic signal with a frequency from 10 cps to 100 kc. A meter, located on the plug-in front panel, indicates when phase lock is achieved. The phase shift between the input signal and the 3300A can be adjusted over a 360 degree range using the phase control and the input phase switch. This feature is particularly useful for generating a variable phase output at frequencies greater than 10 cps.

The instrument may also be phase-locked to a harmonic of an externally applied signal, making it useful for synthesis of complex waveforms. In addition, the 3300A may be phase-locked to an external source to obtain sine, triangle, and square wave outputs with frequency characteristics of the externally applied signal.

TENTATIVE SPECIFICATIONS

(Basic Unit)

***Available Plug-In Units:**
Model 3301A Auxiliary Plug-In
Model 3302A Trigger Plug-In

*3300A requires a plug-in to operate

Output Waveforms: Sinusoidal, square, and triangular selected by panel switch. (Any two outputs available simultaneously).

Frequency Range: 0.01 cps to 100 kc in seven decade ranges.

Frequency Response: ±1%, 0.01 cps to 10 kc; ±3%, 10 kc to 100 kc.

Dial Accuracy: ±1% of maximum dial setting, .01 cps to 10 kc; ±2%, 10 kc to 100 kc.

Maximum Output Per Channel: >35 volts peak-peak open circuit; 15 volts peak-peak into 600 ohms; 2 volts peak-peak into 50 ohms.

Output Attenuator: Continuously variable, >40 db range.

Output Impedance: 600Ω nominal.

Sine Wave Distortion: <1%, 0.01 cps to 10 kc; <3%, 10 kc to 100 kc.

Square Wave Response: <250 nsec rise and fall time on all ranges; <1% sag, <5% overshoot.

Triangle Linearity: <1% 0.01 cps to 50 kc; 2%, 50 kc to 100 kc; <1% symmetry error.

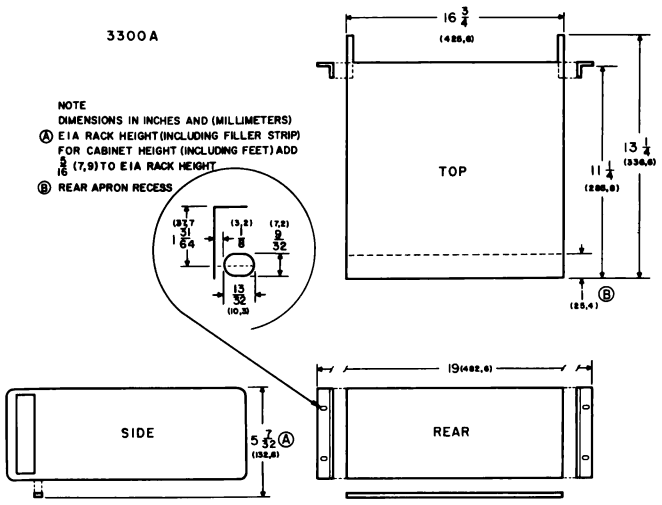
Sync Pulse Output: > —10 volts peak, open circuit <5 μsec duration. Sync pulse occurs at crest of sine and triangular wave output.

DC Stability: Drift <±0.5% of peak-to-peak amplitude.

Remote Frequency Control: —0.5 to —10 volts will linearly change frequency over 1 decade within a single range. Frequency linearity with respect to voltage ±1% of maximum frequency on range selected.

Power: 115 or 230 volts, ±10%, 50 to 1000 cps. Approximately 50 watts.

Outline Drawing: Standard ⓗ full module; 5" high, 16" wide, 11" deep. (127 x 406 x 279 mm).



Weight: Net: 20 lbs. (9 kg) Shipping: 24 lbs. (10,8 kg).

3302A TRIGGER/PHASE LOCK PLUG-IN

Modes of Operation:

Single cycle
Multiple cycle
Phase lock
Free run

TRIGGER REQUIREMENTS:

Single Cycle: Manual or external. DC coupled. Requires at least 1 volt to trigger externally. May be triggered with positive or negative input voltage.

Multiple Cycle: Manual or external start/stop. DC coupled. Requires at least 1 volt to start, 0 volts to stop. May be triggered with either positive or negative input voltage.

Phase Lock: DC coupled. Requires at least 1 volt peak-to-peak to lock, 10 volts peak-to-peak for specified accuracy with sine wave input.

Phase Accuracy: ±10° from 100 cps to 100 kc. ±20° from 10 cps to 100 cps.

Price: ⓗ 3300A Function Generator: $570.00
ⓗ 3301A Auxiliary Plug-In: $20.00
ⓗ 3302 Trigger/Phase Lock Plug-In: $190.00

Prices f.o.b. factory
Data subject to change without notice
► Indicates change from prior specifications

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SECTION I

GENERAL INFORMATION

Table 1-1. Specifications

FREQUENCY RANGE: 0.01 cps to 100 Kc in seven decade ranges.
FREQUENCY RESPONSE: ±1% 0.01 cps to 10 Kc, ±3% 10 Kc to 100 Kc.
DIAL ACCURACY: ±1% of maximum dial setting .01 cps to 10 Kc; ±2%, 10 Kc to 100 Kc.
MAXIMUM OUTPUT PER CHANNEL: >35 volts peak-to-peak open circuit; 15 volts peak-to-peak into 600 ohms; 2 volts peak-to-peak into 50 ohms.
OUTPUT ATTENUATORS: Continuously variable >40 db range.
OUTPUT IMPEDANCE: 600 ohms nominal
SINE WAVE DISTORTION: <1%, 0.01 cps to 10 Kc; <3%, 10 Kc to 100 Kc.
SQUARE WAVE RESPONSE: <250 n sec. rise and fall time on all ranges; <1% sag; <5% overshoot.
TRIANGLE LINEARITY: <1%, 0.01 cps to 50 Kc; 2% 50 Kc to 100 Kc; <1% symmetry error.
SYNC PULSE OUTPUT: >-10 volts peak open circuit, <5μ sec duration. Sync pulse occurs at crest of sine and triangle wave.
DC STABILITY: Drift <±0.5% of peak-to-peak amplitude.
REMOTE FREQUENCY CONTROL: -0.5 to -10 volts will linearly change freq over one dacade within a single range.
POWER: 115 or 230 volts ±10%, 50 to 1000 cps. Approximately 50 watts.

1-1. GENERAL.

1-2. The Hewlett-Packard Model 3300A Function Generator with the 3301A Auxiliary Plug-in is a solid state instrument useful for most general purpose frequency testing applications. Three output waveforms are available from front panel connectors; sine, square, and triangle. A sync pulse is also available from a rear panel connector.

1-3. The -hp- Model 3300A Function Generator is a type of relaxation oscillator. The triangle and square wave voltage functions of time are inherent in the oscillatory system. The sine wave is produced by synthesis from the triangle wave.

1-4. The -hp- Model 3301A Auxiliary Plug-in provides internal connection for basic unit operation.

1-5. ELECTRONIC FREQUENCY CONTROL.

1-6. Frequency of the -hp- Model 3300A can be controlled by either the front panel frequency dial or an external voltage applied to a rear terminal connector. This feature is useful for sweeping filters, amplifiers and other frequency-dependent devices and for externally programming frequencies for production testing. An input voltage of approximately -0. 5 to -10 volts will linearly control the frequency over any one range.

1-7. OUTPUT SYSTEM.

1-8. The output system of the -hp- Model 3300A is dc coupled and fully floating with respect to power line ground. An internal shield reduces radiated interference and provides common mode rejection with floating output. Separate connectors on the rear panel provide terminals for circuit ground (⏚), output ground (▽), shield ground (Shield ground is not symbolized as the inner case is the shield. The only electrical connection is to the rear terminal marked SHIELD GND.), and power line ground (⏚). The output waveforms may be dc offset up to ±250 volts. Any two of the three waveforms are available simultaneously from the front panel connectors.

1-9. INSTRUMENT IDENTIFICATION.

1-10. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 3300A described in this manual.

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 3300A Function Generator. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the performance checks outlined in Section V.

2-5. POWER REQUIREMENTS.

2-6. The Model 3300A can be operated from any source of 115 or 230 volts (± 10%), at 50 - 1000 cps. With the instrument disconnected from the ac power source, move the slide switch (located on the rear panel) until the desired line voltage appears. Power dissipation is approximately 50 watts.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-10. INSTALLATION.

2-11. The Model 3300A is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F).

2-12. BENCH MOUNTING.

2-13. The Model 3300A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-14. RACK MOUNTING.

2-15. The Model 3300A may be rack mounted by using the 5" Rack Mount

Kit (-hp- Part No. 5060-0775). Instructions for the conversion are included with the kit. The rack mount for the Model 3300A is a standard width of 19 inches.

2-16. REPACKAGING FOR SHIPMENT.

2-17. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-18 if the original container is to be used: 2-19 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations).

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence. identify the instrument by model number, serial number and serial number prefix.

2-18. If original container is to be used, proceed as follows:

a. Place instrument in original container if available. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

b. Ensure that container is well sealed with strong tape or metal bands.

2-19. If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE", etc.

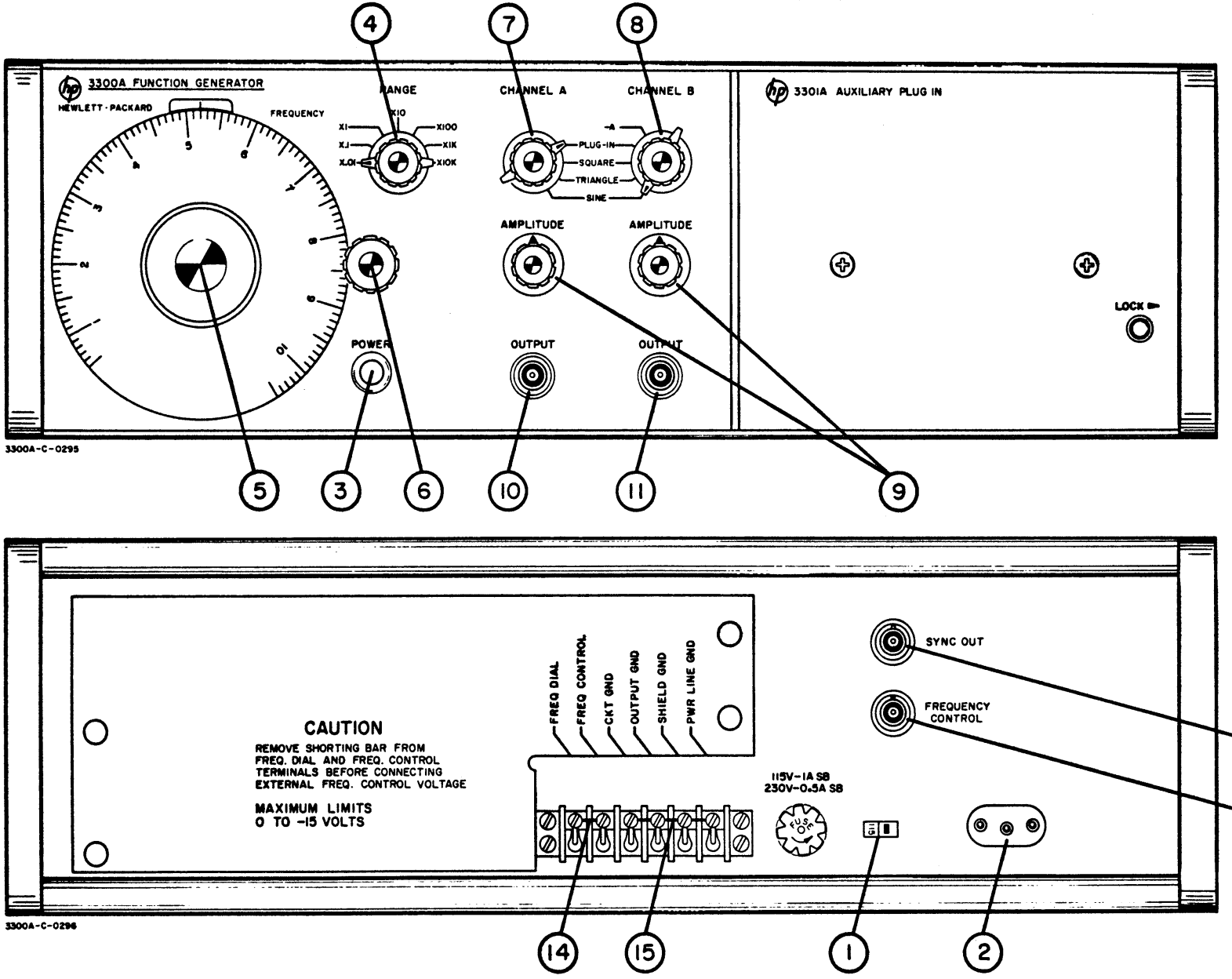


Figure 3-1. Front and Rear Panel Description

SECTION III

OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section consists of instructions and information necessary for the operation of the -hp- Model 3300A Function Generator.

3-3. CONTROLS AND INDICATORS.

3-4. Each operating control and connector located on the 3300A is identified and described in Figure 3-1. The description of each component is keyed to an illustration of that component.

3-5. TURN ON PROCEDURE.

3-6. To turn on the Model 3300A proceed as follows: (Refer to Figure 3-1)

a. Set 115/230 switch (1) to correct position for input line voltage.

b. Apply ac voltage to 3300A by plugging power cord from (2) into power jack.

c. Depress POWER button (3) ensure that light in button illuminates.

3-7. OPERATING INSTRUCTIONS.

3-8. To operate the Model 3300A using the Frequency Dial proceed as follows: (See Figure 3-1).

a. Select desired frequency by setting RANGE switch (4) and FREQUENCY Dial (5).

b. Select desired function by setting CHANNEL A and/or CHANNEL B Function switch (7) (8). PLUG-IN position is used only with future plug-ins.

c. Set amplitude controls (9) for desired output at the OUTPUT bnc connectors (10) (11).

3-9. To control the frequency of the Model 3300A externally, proceed as follows:

a. Remove shorting bar (14).

CAUTION

VOLTAGE APPLIED TO FREQ CONTROL SHOULD BE LIMITED TO A VALUE BETWEEN 0 AND NEGATIVE 15 VOLTS. VOLTAGES OUTSIDE THIS RANGE WILL DAMAGE THE INSTRUMENT.

b. Apply a negative dc voltage from -. 5 to -10 volts to the FREQ CONTROL bnc (12).

c. Select desired frequency range and set amplitude of externally

Figure 3-1. Front and Rear Panel Description

(1) 115v/230v Slide Switch: makes connections in primary of input transformer for selected input line voltage.

(2) Power Input Jack: male receptical for input power cable.

(3) POWER Switch: pushbutton on off switch which illuminates when in the on position and power is applied to the instrument.

(4) RANGE Switch: S3, a seven position rotary switch which selects frequency determining feedback parameters in the basic oscillatory circuit.

(5) FREQUENCY Dial: a linear dial which controls frequency within the decade selected by the RANGE Switch (4).

(6) Vernier Frequency Control: a fine frequency adjustment knob.

(7) CHANNEL A Function Switch: a four position rotary switch which selects the desired OUTPUT (10).

(8) CHANNEL B Function Switch: a five position rotary switch which selects the desired OUTPUT (11).

(9) CHANNEL A and CHANNEL B Amplitude Controls: attenuators which vary the output of the respective channel continuously from max to zero.

(10) and (11)
OUTPUT connectors: bnc jacks for using the respective outputs of the function generator.

(12) FREQ CONTROL: a bnc jack for the input of external frequency control voltage.

(13) SYNC OUT: a bnc jack for using a negative sync pulse which is in phase with the crest of the sine and triangle wave.

(14) FREQ DIAL/FREQ CONTROL Shorting Bar: completes the circuit for the FREQUENCY Dial for internal frequency control.

(15) Common Grounding Strap: ties circuit, output, and shield ground to power line ground.

applied voltage for desired frequency.

d. All 3300A controls except the FREQUENCY Dial are operated in the same manner as in Paragraph 3-8.

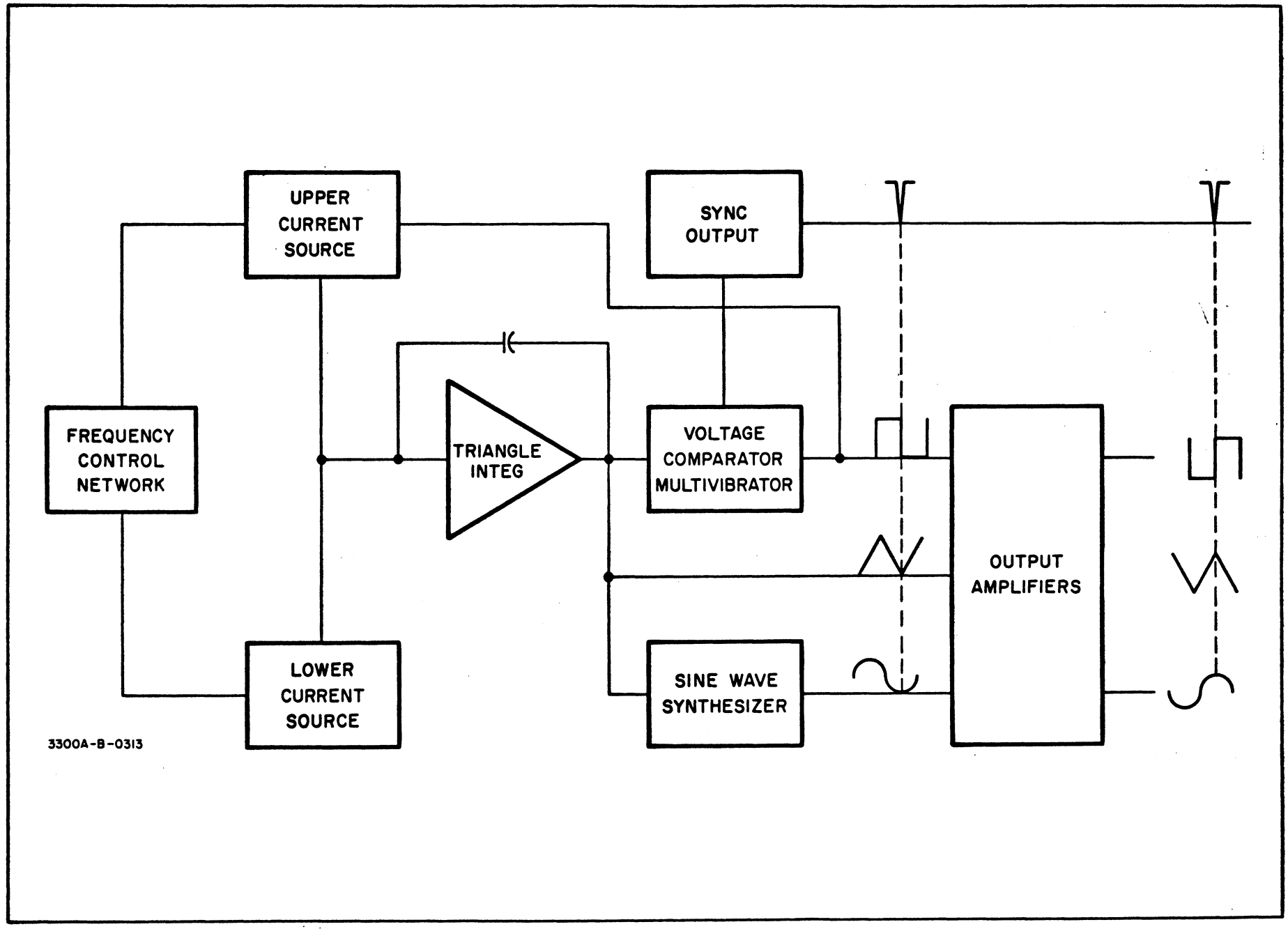

UPPER CURRENT SOURCE
SYNC OUTPUT
FREQUENCY CONTROL NETWORK
TRIANGLE INTEG
VOLTAGE COMPARATOR MULTIVIBRATOR
OUTPUT AMPLIFIERS
LOWER CURRENT SOURCE
SINE WAVE SYNTHESIZER
3300A-B-0313

Figure 4-1.

SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a description of the the theory of operation of the -hp- Model 3300A Function Generator with the -hp- Model 3301A Auxiliary Plug-in.

4-3. GENERAL DESCRIPTION.

4-4. The Model 3300A comprises a frequency control network, two current sources, a triangle integrator, a voltage comparator multivibrator, a sine wave synthesizer and output amplifiers. (Refer to Figure 4-1).

4-5. The Model 3301A Auxiliary Plug-in comprises shorting wires to provide internal connections for Model 3300A operation.

4-6. The voltage comparator multivibrator, current sources and triangle integrator form the basic function generating loop. The voltage comparator multivibrator changes state at predetermined limits on the positive and negative slopes of the output of the triangular integrator. The effect of the change of state in the upper current source, reverses the input to the triangle integrator. A cycle is as follows: when the amplitude of the positive slope of the triangle wave reaches the upper predetermined limit of the voltage comparator multivibrator, the multivibrator changes state. This change of state reverses the current into the triangle integrator through control of the upper current source which causes the output of the integrator to decrease. The decrease continues until the amplitude of the negative slope reaches the lower predetermined limit. At this point, the voltage comparator multivibrator changes state and again reverses the direction of current at the input of the integrator and causes the output of the integrator to rise. This rise continues until the voltage comparator multivibrator again changes state thus completing the cycle.

4-7. The frequency control network, governed internally by the FREQUENCY Dial or externally through the FREQ CONTROL, determines the amount of current in the current sources, which varies the frequency as follows: an increase or decrease in input current increases or decreases the slope of the triangle wave, respectively. (A change in direction of input current reverses the slope.) Frequency will increase if the + and - slopes are increased, as less time is required for the + or - peak of the triangle wave to reach the predetermined limits in the voltage comparator multivibrator.

4-8. The sine wave is synthesized from the triangle wave by a nonlinear network. This network consists of resistors and diodes biased so different diodes conduct during different voltage levels of the triangle wave. These diodes, when conducting, provide additional shunt paths within the network. Each additional shunt path changes the slope of the triangle wave so that the wave is shaped to approximate a sine wave.

4-9. The output amplifiers are dc coupled and fully floating with respect to power line ground. CHANNEL A and CHANNEL B amplifiers are identical and use a differential amplifier at the input. To maintain the same peak-to-peak amplitude regardless of function selected, the overall closed loop gain of the amplifiers is varied with function selection.

4-10. The negative sync pulse is produced by an RC differentiating network. The pulse at the output is in phase with the positive crest of the sine and triangle wave.

4-11. Power Supply (Refer to Figure 6-1) can operate on either 115 or 230 volts input and delivers 3 pairs of voltages, ±40 v, ±26. 5 v and ±20 v. The 40 volt supply provides power for the oven heater. The ±26. 5 v supplies are regulated and the ±20 v supplies are double regulated.

4-12. Critical temperature sensitive components are housed within an oven in which the temperature is maintained at approximately 80°C (176°F).

4-13. SCHEMATIC THEORY.

4-14. FREQUENCY CONTROL NETWORK.

4-15. (Refer to Figure 6-2) The FREQUENCY dial (R4) in conjunction with the RANGE switch (S3) provides internal frequency control. The basic frequency equation can be expressed as $F = \frac{i}{2 c \ \Delta e_{out}}$.

Where i is the current to the triangle integrator, C is the triangle integrator feedback capacitor and Δe_{out} is the peak-to-peak voltage of the triangle wave.

The position of the RANGE switch determines the integrating capacitor C. The FREQUENCY dial or external control voltage determines the current i. The frequency control voltage is applied to the current control transistor A1Q5 which establishes the amount of current available to the triangle intregrator from the current sources A1Q6 and A1Q7.

4-16. Current Sources.

The state of current source A1Q6 is controlled by the voltage comparator multivibrator, and in turn, controls the direction of the current in the input of the triangle integrator. When A1Q6 is on, a current, 2 i, flows through it and divides, i into the integrator and i through current source A1Q7. When the bi-stable multivibrator changes state and gates A1Q6 off, 2 i no longer flows; however, the current through A1Q7 remains the same. Therefore, a current equal to i but opposite in direction flows from the triangle integrator input.

4-17. Triangle Integrator.

The triangle integrator consists of an impedance converter A1Q8 (a Field Effect Transistor), a differential amplifier A3Q1 and A3Q2, an emitter follower A3Q3, diode A3CR1, and the capacitive feedback network: this circuit integrates the constant current inputs into the positive and negative

slopes which make ;up the triangle wave. The triangle wave is applied to the input of the output amplifiers, sine wave synthesizer and voltage comparator multivibrator.

4-18. Voltage Comparator Multivibrator.

The voltage comparator multivibrator consists of a voltage comparator switching network, A4Q8, A4CR13 and A4CR14; a bi-stable multivibrator A4Q9 and A4Q10 and an emitter follower A4Q11. A4CR19 and A4R45 provide a low resistive path to ensure rapid rise and fall time of the square wave in the event the capacitance of the load is high. When the positive slope of the triangle wave reaches +20 volts, A4CR13 is turned on. A4Q9 is then turned on which turns A4Q10 off. The rise in the collector voltage of A4Q10 is coupled through the emitter follower A4Q11 and through A4CR20 and A4CR21 into the emitter circuit of A1Q6, and turns it on. The output slope then becomes negative. A1Q6 remains on until the negative slope reaches zero volts. At the zero volt point on the negative slope A4CR14 is turned on which causes the bi-stable multivibrator to change state so that A4Q9 is now off and A4Q10 is on. The decrease in A4Q10 collector voltage gates the current source, A1Q6, off which reverses the integrater input current. The positive slope then begins increasing toward the upper limit, +20 volts. The output of the emitter follower is differentiated by A4C7 and A4R48 to provide the sync output. A4CR22 eliminates the positive spike and clamps the output waveform to approximately ground potential.

4-19. SINE WAVE SYNTHESIZER.

(See Figure 6-2) The sine wave synthesizer comprises four control transistors, the biased dioded with associated voltage dividers, a differential amplifier A4Q5 - A4Q6 and the output amplifier A4Q7. A4R17 and A4R29 adjust the operating points of the voltage dividers to minimize distortion. The diodes are biased by the four control transistors A4Q1 through A4Q4 and the voltage dividers to provide twelve different current paths in the input to the differential amplifier as the triangle wave progresses. Each slope of the triangle wave is modified in twelve steps so that the waveform appearing at the base of A4Q5 approximates a sine wave. The sine wave synthesizing network is isolated by the differential amplifier A4Q5 and A4Q6 and amplifier A4Q7.

4-20. OUTPUT AMPLIFIERS.

The etched circuit assemblies A5 and A6 are identical. CHANNEL A and CHANNEL B differ due to the -A output of CHANNEL B. The input for CHANNEL B with its function switch in -A position, XA6 Pin E, is taken from the junction of A5R20 and A5R21, XA5 Pin P. The output amplifiers are variable gain amplifiers. Gain is varied by changing the amount of feedback for the different functions. The following reference designators should be prefixed by applicable assembly number. The feedback is varied by resistors R1 through R5 and R23, C8 combination, to maintain equal peak-to-peak amplitude of the various function for a given AMPLITUTUDE control setting. A differential amplifier, Q1 and Q2, make up the first

stage followed by two additional amplifiers Q3 and Q4. The trimmer C2 in the feedback network is used to shape the square wave. The AMPLITUDE control provides a nominal 600 ohms output impedance, independent of amptitude control setting.

4-21. POWER SUPPLY.

The power supply comprises two full wave rectifiers CR1 thru CR4 and four series regulated supplies. A1CR1 provides the reference point for the two negative regulated supplies which in turn are the references for the two positive regulated supplies. The two 20 volt supplies are double regulated. The operation of the four supplies are similar. A differential amplifier senses and amplifies any change. The change is applied through a driver stage to the series regulator which then changes its conduction to oppose the change. The diodes in the + and -26. 5 volt supplies are used to limit the current through the series regulator. The operation is the same in both supplies, the +26. 5 supply is discussed. As the current through Q1 increases the IR drop across A2R5 and A2R6 increases. This increase decreases the forward bias on Q1 which decreases the current through Q1. The forward bias on Q1 is a function VBE of A2Q2, the breakdown voltage of the forward biased crystal diode A2CR2 through A2CR5, and the variable IR drop across the parallel network of A2R5 and A2R6.

4-22. OVEN.

(See Figure 6-2) The oven temperature is automatically maintained at the desired temperature by a thermal control loop. The loop consists of a thermistor, a signal amplifier, a power amplifier, and the heater resistors. The operation of the loop is as follows: the resistance of RT1 (thermistor) decreases with an increase in temperature which causes the base voltage of A1Q9 to rise. The corresponding decrease of A1Q9 collector voltage is coupled into the base circuit of the power amplifier Q9. The collector current of Q9 then decreases which decreases the current through the heater resistors. Less current in the heater resistors generates less heat and the temperature decreases. The response of the loop is improved by the physical location of A1R27 in close proximity to the thermistor.

Table 5-1. Required Test Equipment

Instrument Type	Required Characteristics	Recommended Instrument
Electronic Counter	Range: dc to 100 Kc	-hp- 5245L Electronic Counter with 5262A Plug-in Time Interval Unit
Distortion Analyzer	Range: 10 cps to 100 Kc Freq. Accuracy: ±2% Sensitivity: 0.3% full scale Input: 1 volt rms	-hp- Model 331A Distortion Analyzer
Oscilloscope	Sensitivity: 50 mv/cm Bandwidth: DC - 20 Mc	-hp- 175A Oscilla-scope with -hp- Plug-in 1750A Vertical Amplifier
Probe 10:1	Bandwidth: dc to 30 Mc Division Accuracy: ±2%	-hp- 10001A Probe 10:1 Digital Voltmeter
DC Voltmeter	Accuracy: ± .1% F.S. Range: 10 mv to 50 v Input Impedance 10 meg	-hp- 3440A Digital Voltmeter with Plug-in -hp- 3443A
Resistor	 600 ohms 1/4 w ±5% 50 ohms 1/4 w ±5% 10 K 1/4 w ±5%	-hp- Part No. 0730-0010 0683-5105 0684-1031
Capacitor	 1 μf 50 v	-hp- Part No. 0170-0018
Variable Line Voltage Trans-former	Range: 100 to 130 v Accuracy: ±3% F.S.	Superior Type VCIM
DC Power Supply	Range: 0 - 10 volts	-hp- 723A Power Supply
AC Voltmeter	Range: 10 cps to 4 Mc	-hp- 400H Vacuum Tube Voltmeter
Printed Circuit Extender board	 15 Pin	-hp- Part No. 5060-0049
Printed Circuit Extender board	 22 Pin	-hp- Part No. 5060-0630

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for the proper maintenance of the -hp- Model 3300A Function Generator.

5-3. Required test equipment is listed in Table 5-1. Test equipment with comparable characteristics can be substituted.

5-4. PERFORMANCE CHECKS.

5-5. The performance checks presented in this section are front panel procedures designed to compare the -hp- Model 3300A with the -hp- Model 3301A Plug-in with its specifications. These operations should be completed before any attempt is made to adjust or calibrate the instrument. Allow a 30 minute warm-up period before making performance checks. If a performance check indicates that the instrument does not meet specifications (see Table 1-1) refer to the applicable paragraph in the adjustment and calibration procedure contained in this section.

5-6. DIAL ACCURACY.

a. Test equipment required: Frequency Counter (-hp- Model 5245L).

b. Connect the output of CHANNEL A to the frequency counter and set the 3300A control as follows:

FREQUENCY DIAL. 10

CHANNEL A function switch. . . . . .SINE

CHANNEL A AMPLITUDE control. . . as required to trigger the counter

c. Check frequency for each position of RANGE switch.

d. Accuracy should be within ±1% of frequency setting for ranges X.01 through X1 K and ±2% of frequency setting for X10 K range.

5-7. DISTORTION CHECK.

a. Test equipment required: Distortion Analyzer (-hp- Model 331A).

b. Connect the OUTPUT of CHANNEL A to distortion analyzer and set 3300A controls as follows:

FREQUENCY DIAL. 10

RANGE switch . . . . . .X1 K

CHANNEL A function switch. . . . . .SINE

c. Distortion should be less than 1%.

5-8. Test set up is as in 5-7 except position the RANGE switch to X10 K Distortion should be less than 3%.

NOTE

The sine function is electronically synthesized from the triangle frunction. Satisfactory performance of Distortion Check assures symmetry.

5-9. MAXIMUM OUTPUT LEVEL, NO LOAD.

a. Test equipment required: Oscilloscope (-hp- Model 175A/1750A).

b. Connect the OUTPUT of CHANNEL A to Oscilloscope and set 3300A controls as follows:

CHANNEL A function switch. . . . . .SQUARE

CHANNEL A AMPLITUDE control . . .Maximum C.W.

c. The peak-to-peak voltage should be > 35 volts over entire frequency range.

5-10. Repeat 5-9 above except with CHANNEL A Function Switch set to TRIANGLE. The minimum peak-to-peak voltage remains 35 volts.

5-11. Repeat 5-9 with CHANNEL A Function Switch set to SINE. The minimum peak-to-peak voltage remains 35.

5-12. Repeat 5-9, 5-10 and 5-11 on CHANNEL B.

5-13. MAXIMUM OUTPUT LEVEL, LOADED.

a. Test equipment required: Oscilloscope (-hp- Model 175A1750A), 600 ohm, and 50 ohm resistor.

b. Load the OUTPUT of CHANNEL A with the 600 ohm resistor and connect the output to the oscilloscope as shown in Figure 5-1. Set the 3300A controls as follows:

FREQUENCY DIAL. 10

RANGE Switch X100

CHANNEL A AMPLITUDE Control . . Maximum C.W.

CHANNEL A Function Switch . . . . . SQUARE

c. Peak-to-peak voltage should be > 15 volts.

5-14. Repeat 5-13 on CHANNEL B. Limit remains the same peak-to-peak voltage > 15 volts.

5-15. Repeat 5-13 and 5-14 except load the instrument with the 50 ohm resistor. CHANNEL A and CHANNEL B voltage output should be > 2 volts peak-to-peak.

5-16. SQUARE WAVE RESPONSE.

a. Test equipment required: Oscilloscope (-hp- Model 173A/1700A) and 10:1 Probe (-hp- 10001A).

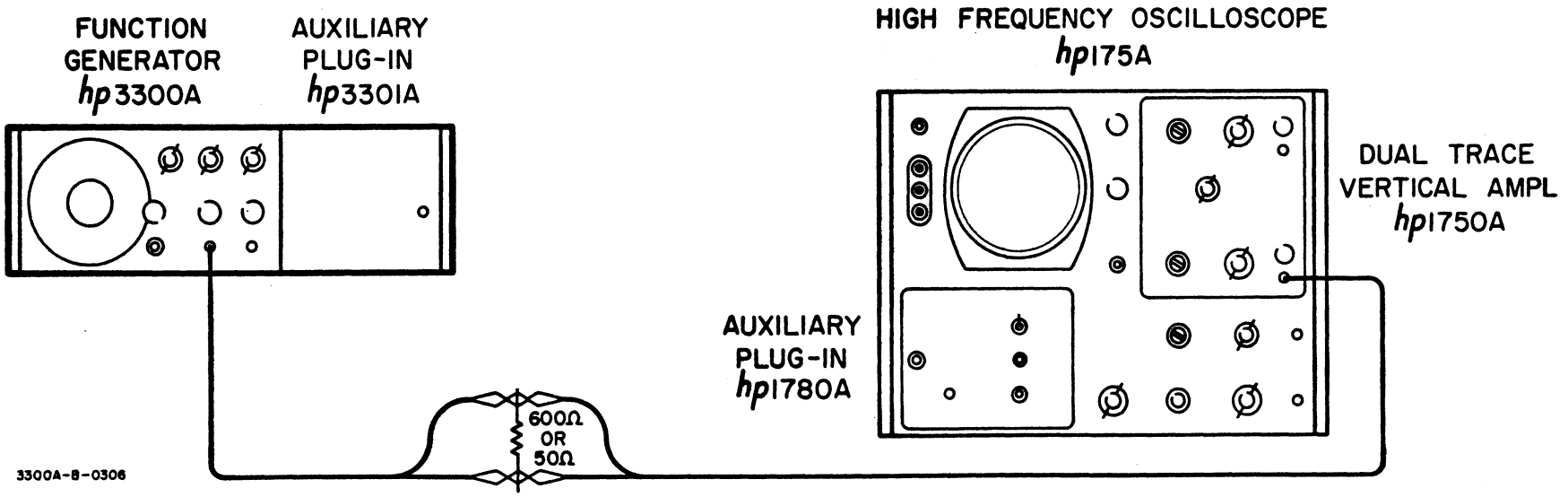


Figure 5-1. 600 ohm or 50 ohm Load Output Test Setup

b. Connect CHANNEL A OUTPUT without a load to the oscilloscope using the 10:1 Probe, and set the 3300A controls as follows:

CHANNEL A Function Switch . . . . SQUARE

FREQUENCY DIAL 10

RANGE Switch . . . . . 10 K

c. Rise and fall time should be . . . . . <250 nano sec.
Sag should be . . . . . <1%
Overshoot should be . . . . . <5%

5-17. Repeat 5-16 on CHANNEL B.

5-18. SYNC OUTPUT.

a. Test equipment required: Oscilloscope (-hp- Model 175A/1750A)

b. Connect SYNC OUTPUT to oscilloscope and set 3300A controls as follows:

FREQUENCY DIAL 10

RANGE Switch. . . . . X1 K

c. Pulse should be > -10 volts peak and < 5 microsec duration.

5-19. REMOTE FREQ CHECK.

a. Test equipment required: DC Power Supply (-hp- Model 721A) and Oscilloscope (-hp- Model 175A).

CAUTION

VOLTAGE APPLIED TO FREQ CONTROL SHOULD BE LIMITED TO A VALUE BETWEEN 0 AND NEGATIVE 15 VOLTS. VOLTAGES OUTSIDE THIS RANGE WILL DAMAGE THE INSTRUMENT.

b. Connect the instruments as shown in Figure 5-2.

c. Set 3300A controls as follows:

CHANNEL A Function Switch. . . . . SINE

RANGE Switch. X10

CHANNEL A AMPLITUDE . . . . . FULLY C.W.

d. Monitor frequency as power supply is varied from 0 to -10 volts. Frequency should vary from over the decade, 10 to 100 cycles.

5-20. CHANNEL B-A CHECK.

a. Test equipment needed: Oscilloscope. (-hp- Model 175A/1750A)

b. Connect CHANNEL A OUTPUT to one channel of the oscilloscope and CHANNEL B OUTPUT to the other channel of the oscilloscope.

c. Set 3300A controls as follows:

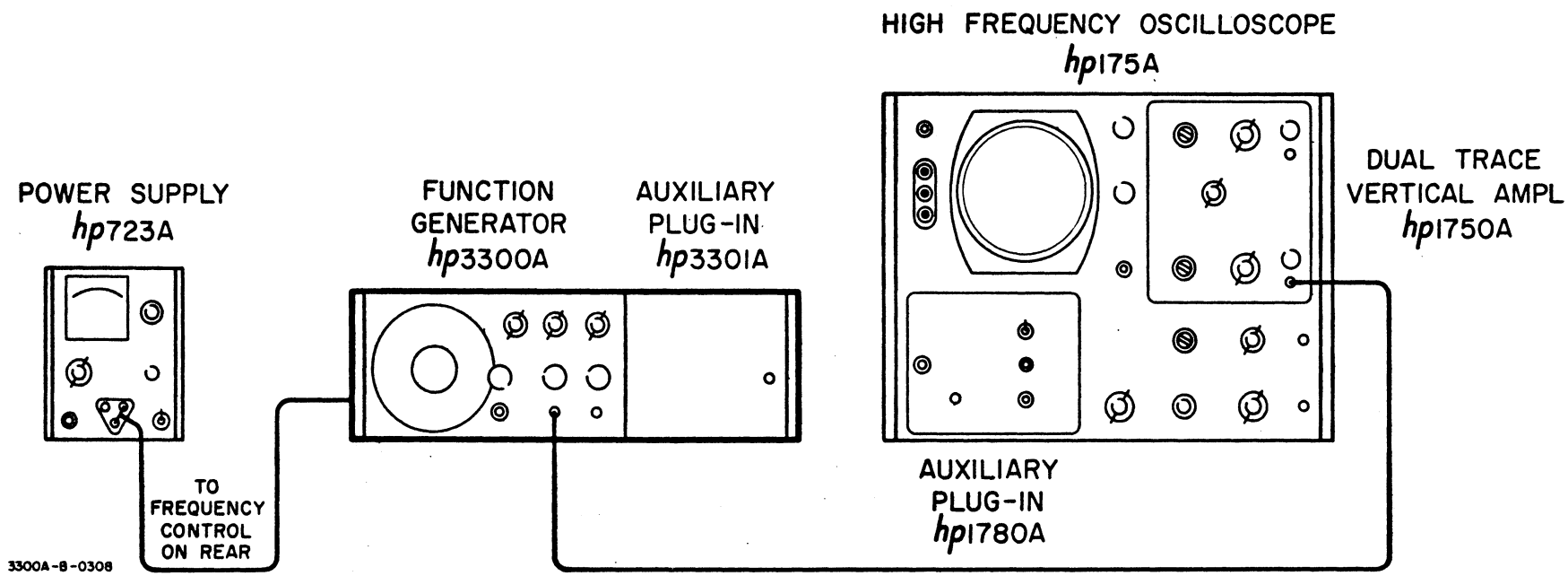


Figure 5-2. Remote Frequency Control Test Setup

CHANNEL A Function Switch . . . . SINE

CHANNEL B Function Switch . . . . -A

d. The output of CHANNEL B should be a sine wave but 180° out of phase with the OUTPUT of CHANNEL A.

5-21. REPAIR PROCEDURES.

5-22. COVER REMOVAL.

When it is necessary to repair or adjust the Model 3300A, one or more covers will have to be removed. To remove either the top or bottom cover, remove the two phillips screws and slide the cover to the rear.

5-23. SERVICING ETCHED CIRCUIT BOARDS.

5-24. The Model 3300A has six etched circuit boards. Use caution when removing them to avoid damaging mounted components. The -hp- Part No. for the assembly is marked on the circuit board to identify it. Refer to Section VII for parts replacement and -hp- Part No. information. The etched circuit boards are of the plated-through type. The electrical connection between the two sides of the board is made by a layer of metal plated through the component hole. When working on these boards, observe the following rules:

CAUTION

THE CIRCUIT BOARDS IN THE 3300A CONTAIN VERY HIGH IMPEDANCE AND HIGH FREQUENCY CIRCUITS. TO AVOID CONTAMINATION OF THESE CIRCUIT BOARDS, AND SUBSEQUENCY HIGH RESISTANCE LEAKAGE PATHS, IT IS IMPORTANT THAT THE FOLLOWING RULES BE STRICTLY OBSERVED.

a. Use a low-heat (25 to 30 watts) small-tip soldering iron, and a small diameter rosin core solder.

b. Remove circuit components by placing the soldering iron on the component lead on either side of the board, and pulling up on the lead. If a component is obviously damaged, clip leads off as close to the component as possible and then remove leads with a soldering iron.

CAUTION

EXCESSIVE HEAT CAN CAUSE THE CIRCUIT AND BOARD TO SEPARATE, OR CAUSE DAMAGE TO THE COMPONENTS.

c. Clean component lead hole by heating the hole with the iron and inserting a wooden toothpick. Remove the toothpick after the solder has cooled and insert the new component lead.

d. To replace components, shape new leads and insert them in lead holes. Reheat with soldering iron and adda small amount of new solder as required to insure a good electrical connection.

e. Clean excessive flux from the connection and adjoining area.

CAUTION

TO AVOID SURFACE CONTAMINATION OF THE PRINTED CIRCUIT, CLEAN WITH A WEAK SOLUTION OF WARM WATER AND MILD DETERGENT AFTER REPAIR. RINSE THOROUGHLY WITH CLEAN WATER AND ALLOW IT TO DRY COMPLETELY BEFORE OPERATING. DO NOT USE ALCOHOL OR ANY OTHER CLEANING SOLUTION EXCEPT DETERGENT AND WATER. DO NOT APPLY ANY COMMERCIAL MOISTURE SEALING SPRAY TO THE BOARDS. APPLICATION OF THESE AGENTS WILL CAUSE LEAKAGE PATHS AND SUBSEQUENT DETERIORATION TO THE OPERATION OF THE INSTRUMENT.

f. Wear clean cotton or rubber gloves when handling the circuit boards. Avoid touching the board or components with bare fingers as skin oils can cause contamination and leakage paths.

5-25. SERVICING ROTARY SWITCHES.

5-26. The 3300A has three rotary type switches; RANGE, CHANNEL A, and CHANNEL B. When working on these switches, observe the following rules:

a. Use a low-heat (25 to 50 watts) small-tip soldering iron, and a small diameter rosin core solder.

b. When replacing components, attempt to dress them as nearly to their original alignment as possible.

c. Clean excessive flux from the connection and adjoining area.

5-27. FEEDBACK CAPACITOR REPLACEMENT.

Should it become necessary to replace any of the capacitors in the feedback circuit of the triangle integrator, the replacement capacitor (a good quality mylar film type) must be selected so that the approximate parallel capacitance is as indicated in the following table.

Table 5-2. Integrator Feedback Capacitance

Designated Capacitors	Padding Capacitors	RANGE	Approximate
C7	C16, C17 and possible C18	X. 01, X1	11 μf
A3C13	C14 and C15	X. 1, X10	1. 1 μf
A3C10	C11 and C12	X100	0. 11 μf
A3C7	C8 and C9	X1 K	0. 011 μf
A3C6	C5	X10 K	0. 0011 μf

If after capacitor replacement, the resultant frequency is not correct, the necessary capacitor change can be determined by the following formula:

$$C_{correction} = \frac{C\ feedback}{\frac{(Freq - desired\ Freq)}{(desired\ Freq)}} X100$$

Example: X1 K range inaccurate

Freq. 9.8 Kc (Range X1 K dial 10)

$$C_{correction} = \frac{0.011\ \mu f}{\frac{(9.8\ K - 10\ K)\ X100}{10\ Kc}}$$

$$= -\frac{0.011}{8} = -.00137\ \mu f$$

5-28. ADJUSTMENT AND CALIBRATION.

5-29. POWER SUPPLY ADJUSTMENTS.

5-30. The adjustment and calibration procedures are designed to adjust and calibrate the -hp- Model 3300A and should be undertaken only if the performance checks indicate the instrument does not meet specifications (see Figure 5-3 for adjustment identification and location)

5-31. The measurement points, adjustments and voltage limits are given in Table 5-3. Refer to Figure 5-4 for convienent top and bottom chassis location for monitoring supply voltages. Supplies should be adjusted in the following order: -26.5 v, +26.5 v, -20 v, +20 v. The supplies should be rechecked and, if necessary, readjusted in the same order

Table 5-3. Power Supply Adjustment

POWER SUPPLY	MEASUREMENT POINT	ADJUSTMENT	VOLTAGE LIMITS
+40	ANY RED WIRE	NONE	+40 ±3 v
-40	ANY VIOLET WIRE	NONE	-40 ±3 v
+26.5	ANY WHITE/RED WIRE	A2R7	+26.50±.02v
-26.5	ANY WHITE/VIOLET WIRE	A2R20	-26.50±.02v
+20	ANY WHITE/BLACK/RED WIRE	R2	+20.00±.01v
-20	ANY WHITE/BLACK/VIOLET WIRE	R3	-20.00±.01v

5-32. POWER SUPPLY RIPPLE CHECK.

a. Test equipment required: AC Voltmeter (-hp- Model 400D)

b. With the AC Voltmeter, check the regulated power supplied (±26.5 v and ±20.00 v) for ripple.

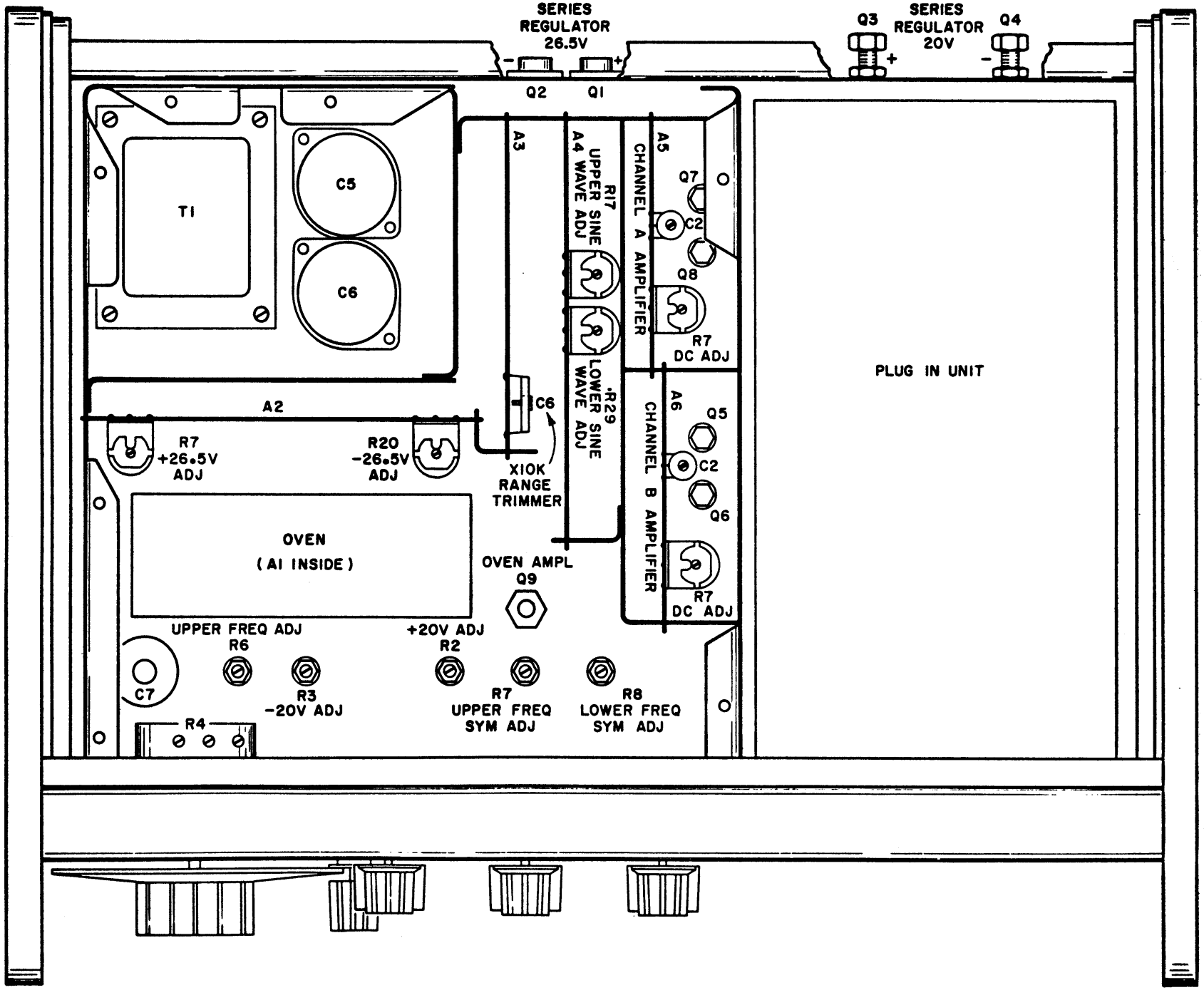
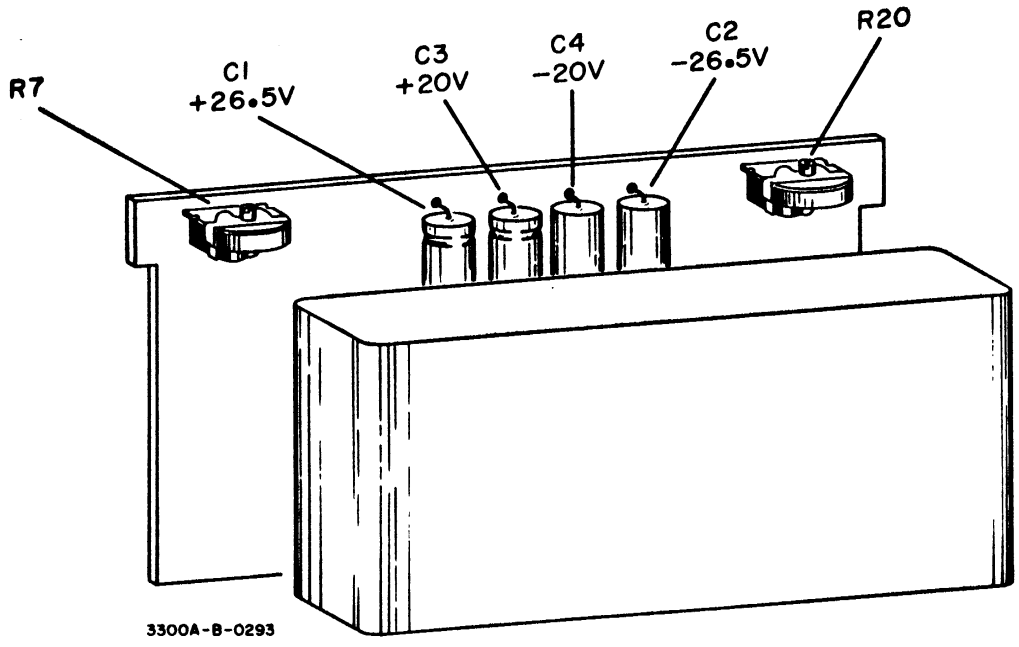


Figure 5-3. Top View


R7
C1
+26.5V
C3
+20V
C4
-20V
C2
-26.5V
R20
3300A-B-0293

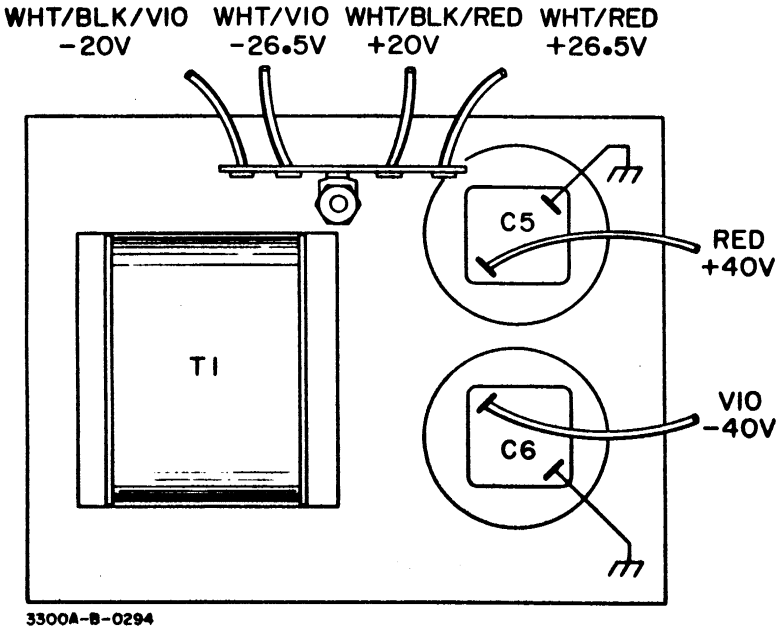

WHT/BLK/VIO
-20V
WHT/VIO
-26.5V
WHT/BLK/RED
+20V
WHT/RED
+26.5V
C5
RED
+40V
T1
VIO
-40V
C6
3300A-B-0294

Figure 5-4.

c. Ripple should be < 20 millivolts.

5-33. POWER SUPPLY REGULATION CHECK.

a. Test equipment required: DC Voltmeter (-hp- Model 3440A/3443A) and Variable Line Voltage Transformer.

b. Apply power to the 3300A through the variable line voltage transformer.

c. With the DC Voltmeter, check the regulated power supplies as input voltage to the 3300A is varied from 103 to 127 Vac. (207 to 253 Vac)

5-34. OVEN REGULATION.

a. After 3300A has been on approximately 30 min, connect a DC voltmeter between circuit ground and collector of Q9 (Standoff with 2 blue wires terminated on it under Q9 bottom chassis). Voltage noted should be approximately 20.

NOTE

This voltage will vary with oven amplifier transistors.

b. Turn 3300A off for approximately 1 min, then turn on. Voltage should have decreased to approximately 15 volts. Voltage will then increase and overshoot that noted in step a but in time damp out to it.

5-35. FREQUENCY SYMMETRY ADJ.

5-36. Lower Frequency Symmetry Adj.

a. Test equipment required: Electronic counter (-hp- Model 5245L with 5262 Time interval Plug-in)

b. Connect the 3300A to the -hp- 5245L/5262L Plug-in.

c. Set the 3300A controls as follows:

FREQUENCY DIAL 1

RANGE Switch X.1

CHANNEL A Function Switch . . . . SQUARE

d. Measure t_1 and adjust R8 to make $t_2 = t_1$. Ref. Figure 5-4

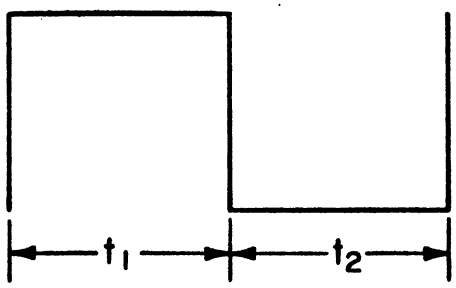


Figure 5-5.

5-37. Upper Frequency Symmetry Adjust.

With same set up as used for 5-35, except select X100 on the RANGE Switch, adjust R7 to equalize t_1 and t_2.

NOTE

Lower FREQ. ADJUST must be made before this adjustment.

Symmetry error should be $< 1\%$.

5-38. FREQUENCY CALIBRATE.

5-39. Dial Adjustment.

a. Test equipment required: Frequency Counter.

b. Connect the output of CHANNEL A to the Frequency Counter and set 3300A control as follows:

RANGE Switch. X100

CHANNEL A Function Switch . . . . .SINE

c. Loosen dial from hub and adjust the frequency of 3300A to exactly 100 cps by rotating the hub. Set the dial to read "1" and tighten the dial to the hub. Recheck the frequency.

5-40. DIAL CALIBRATE.

5-41. With test equipment and 3300A Switches as in 5-34, turn FREQUENCY Dial to "10"and adjust R6 Dial calibrate adjust for 1 Kc output frequency.

5-42. X10 K RANGE CALIBRATE.

5-43. With test set up as in 5-35, set RANGE Switch to X10 K and FREQUENCY Dial to "10" Adjust A3C6, 100 Kc Dial calibrate adjust, for an output frequency of 100 Kc.

5-44. DISTORTION ADJUST.

a. Test equipment required: Distortion Analyzer.

b. Connect output of Channel A to distortion analyzer and set Model 3300A controls as follows:

FREQUENCY Dial 10

RANGE Switch X100

CHANNEL A Function Switch . . . . SINE

c. Adjust A4R17, Upper SINE ADJUST and A4R29 Lower SINE ADJUST, for minimum distortion.

d. Distortion should be $< 1\%$.

5-45. DC OUTPUT LEVEL ADJUST.

a. Test equipment required: RC Filter.

b. Connect CHANNEL A OUTPUT to DC Voltmeter through a filter as shown in Figure 5-6.

c. Set 3300A controls as follows:

RANGE Switch	X100
FREQUENCY Dial	X10
CHANNEL A Function Switch	Vary
CHANNEL A AMPLITUDE	Max. CW

d. Check dc output level on all three functions. Adjust A4R7, DC OUTPUT LEVEL ADJUST, for minimum absolute voltage on all function. DC Levels should be < 200 mv.

NOTE

A5R7 setting should result in a compromise with minimums being of either polarity.

5-46. Repeat 5-41 for CHANNEL B. Adjust A6R7.

5-47. SQUARE WAVE ADJUST.

a. Test equipment needed: Oscilloscope and 10:1 Probe.

b. Connect the OUTPUT of CHANNEL A to the oscilloscope using the 10:1 Probe.

c. Set 3300A controls as follows:

CHANNEL A Function Switch	SQUARE
FREQUENCY Dial	10
RANGE Switch	X10 K

d. Adjust A5C2, SQUARE WAVE ADJUST, for minimum rise time with less than 5% overshoot on the squarewave. Rise time should be < 250 nsec.

5-48. Repeat 5-46 for CHANNEL B. Adjust A6C2.

5-49. TROUBLESHOOTING PROCEDURE.

5-50. This section contain procedure designed to assist in the isolation of a malfunction. These procedures are based on a systematic analysis of the instrument in an effort to localize the problem. These operations should be undertaken only after it has been established that the difficulty can not be eliminated by the adjustment and calibration procedures. An investigation should also be made to ensure that the trouble is not a result of conditions external to the 3300A.

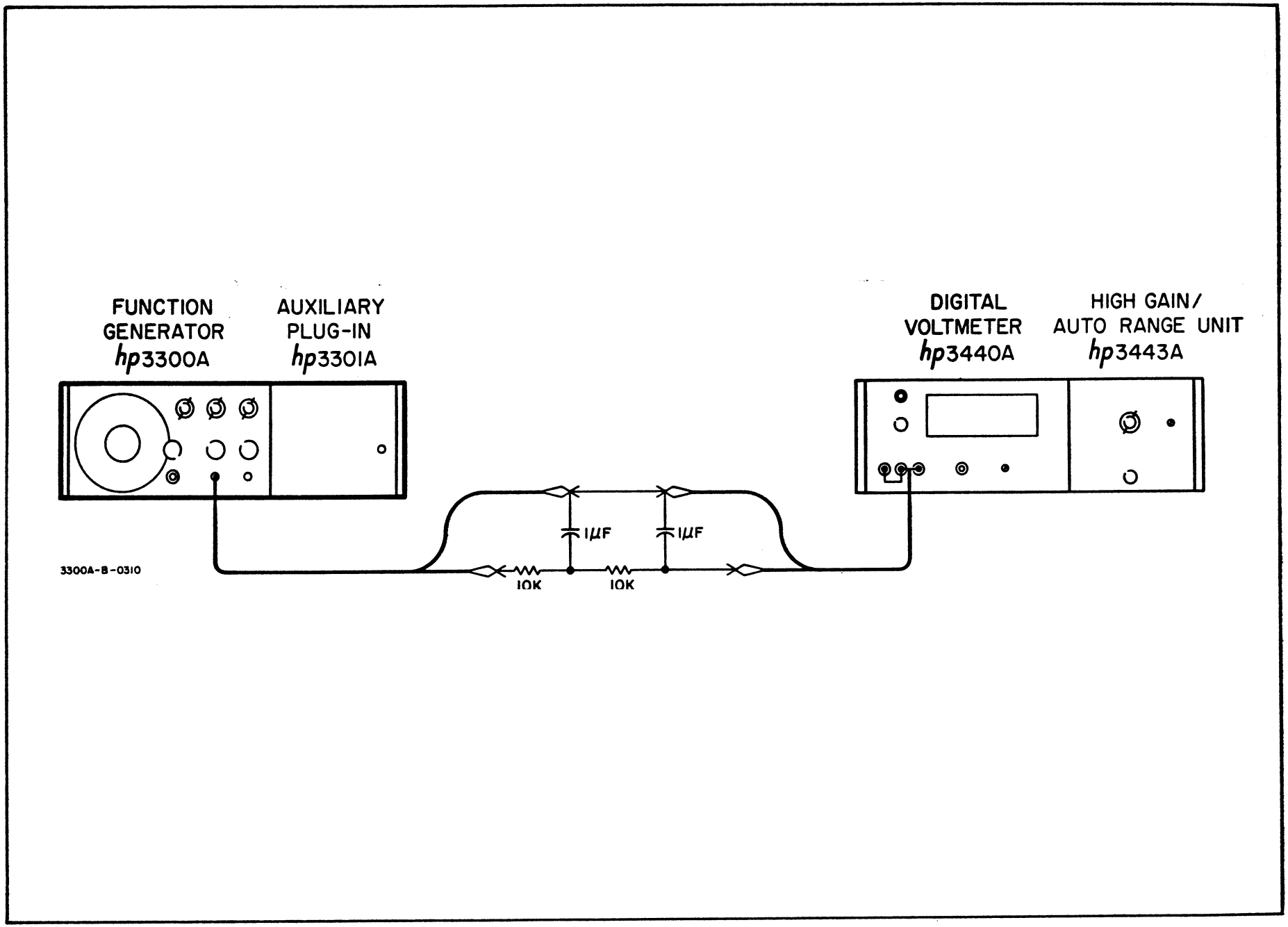


Figure 5-6. DC Output Level Adjust Test Setup

5-51. Conduct a visual check of the 3300A for possible burned or loose components, loose connections, or any other obvious condition which might be a source of trouble.

5-52. The checks outlined in this section are not designed to measure all circuit parameters, rather only to localize the malfunction. Therefore, it is highly probable that additional checks and measurements will be required to completely isolate the faulty component. Amplifier gain may also vary slightly between instrument; therefore, it should not be necessary to precisely duplicate waveforms or voltages described.

5-53. In the event the -20 volt supply is inoperative, the oven heater should be disabled while troubleshooting. A point to disable the oven is to disconnect the smaller dismeter red wire (26 gage) from XA2 Pin 1. The larger diameter red wire (gage 22) should be left connected to XA2 Pin 1. When the -20 volt power supply is out, the oven remains in a full heat condition. Damage to the oven and A1 etched circuit board will result if this heat condition exsists for any extended period.

5-54. Table 5-4 contains a summary of the front panel symptoms that can be used in initial efforts to select a starting point for the troubleshooting operations.

Table 5-4. Troubleshooting Aid

SYMPTOM	POSSIBLE CAUSE
No output either channel. On lamp on	Use Figure 5-7 Troubleshooting Tree
Output on only one channel	Check applicable amplifier board A5 CHANNEL A or A6 CHANNEL B.
Frequency incorrect specific range	Check Feedback capacitor of effected range in triangle integrator; for example, Range X100 check C10, C11, and C12.
Two of the three functions normal, only one channel effected.	Check input resistor of missing function; for example, no sine on CHANNEL A. Check A5R1.
Frequency incorrect at low end of dial, all ranges	Check oven heating collector voltage of Q9 $\simeq$ 20 volts.
Frequency will not vary with FREQ DIAL.	Check Freq shorting bar rear chassis; A1Q5 and associated circuit parameters.
No Sync Output	Check A4C7, A4R48 and A4CR22

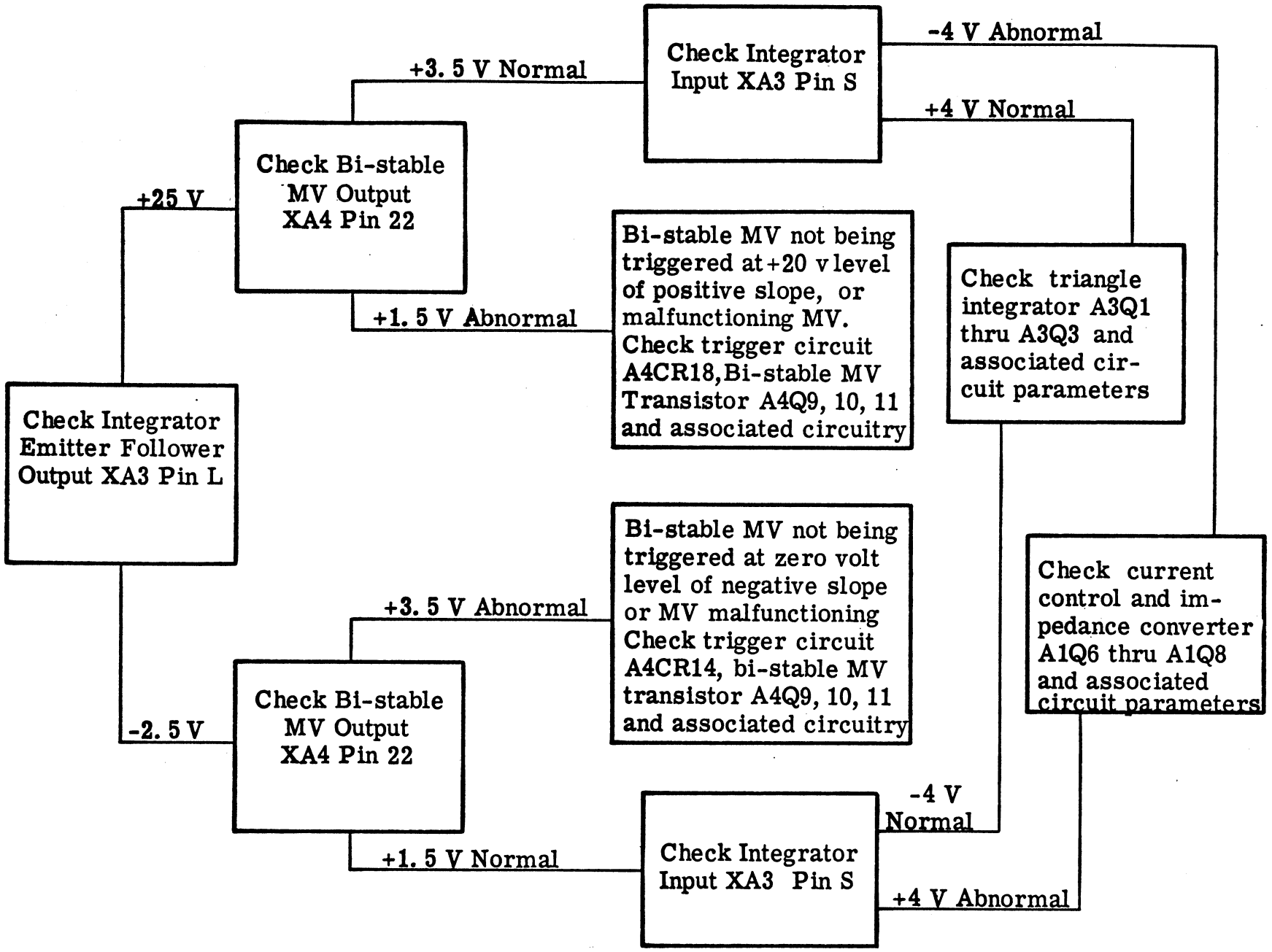


Figure 5-7. Troubleshooting Tree

5-55. In the event of a malfunction which causes the basic oscillatory system to cease functioning; the output of the triangle integrator emitter follower would most likely stabilize at either of two points, the upper limit of the positive slope at approximately 25 volts or the lower limit of the negative slope at approximately -2. 5 v. The condition or state of the output of the other major circuits in the basic oscillating loop, the voltage comparator bistable multivibrator and current source, can, in most instances, be used to isolate the malfunction to a given circuit.(Ref. Figure 5-7) The term normal, as applied to the results obtained at the different points tested, refers to the output at that point which would reverse the slope at the output of the triangle integrator and sustain oscillation. Abnormal refers to that output which would produce the same slope and prevent oscillation.

5-56. Figure 5-8 contains the normal voltage and waveforms which should be present at the points indicated. Voltage levels are approximate and may vary from instrument to instrument due to differences in transistors.

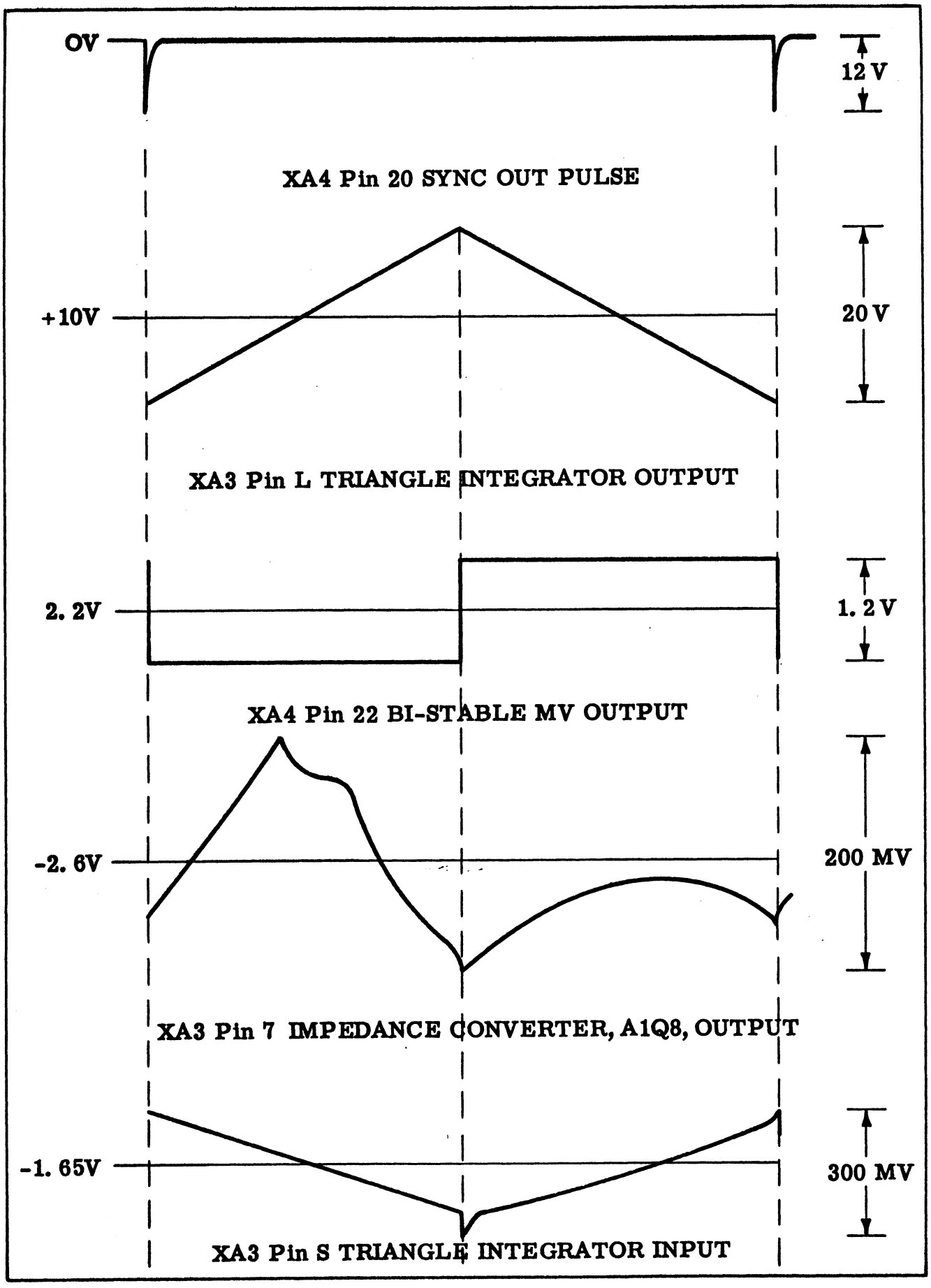


Figure 5-8. Normal Oscillator Wave Forms

SECTION VI

CIRCUIT DIAGRAMS

6-1. INTRODUCTION.

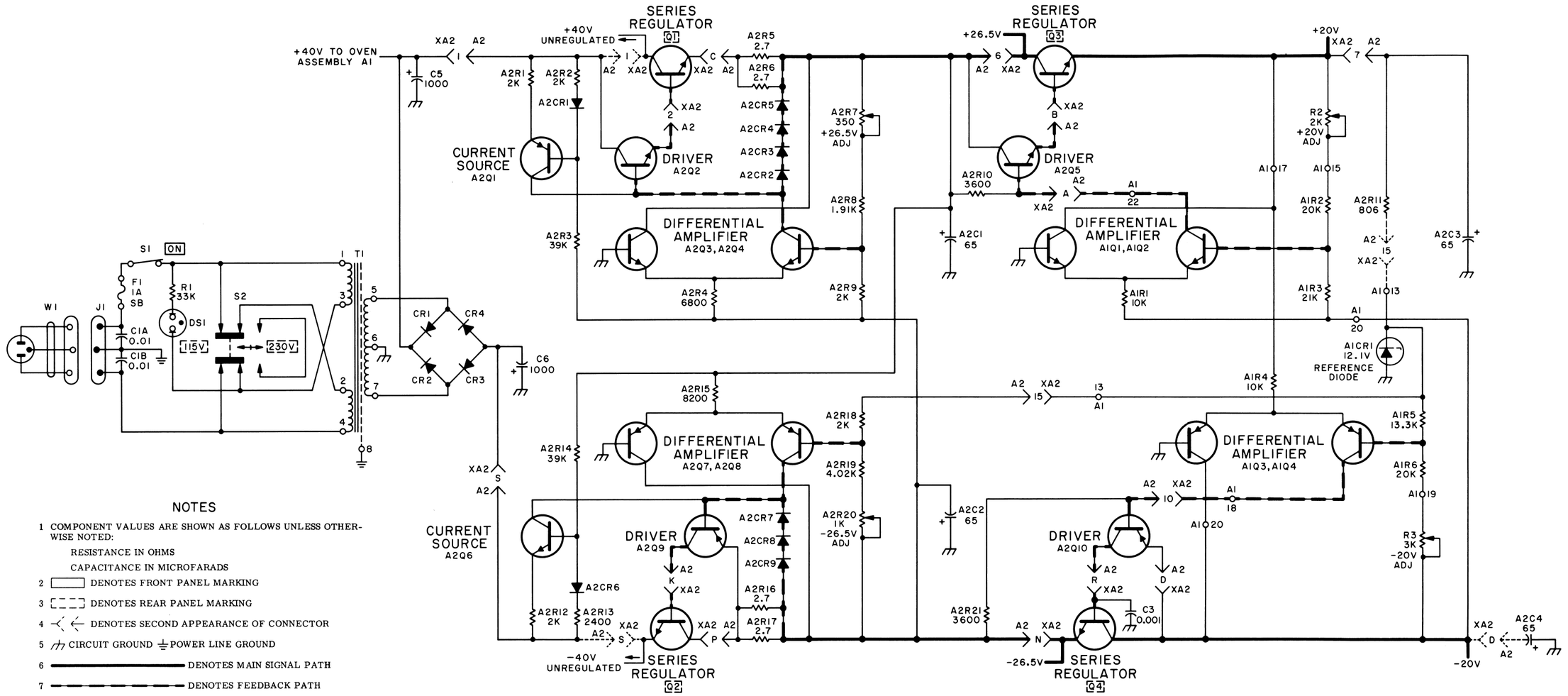
6-2. This section contains schematics and location diagrams for the Model 3300A Function Generator.

6-3. SCHEMATIC DIAGRAMS.

The schematic diagrams are laid out to facilitate ease of following signal flow and detailed theory of the basic function generator. Etched circuit board integrity is maintained whenever possible.

6-4. LOCATION DIAGRAMS.

The location diagrams (Figures 6-3 through 6-7) depicts the physical location of components on the etched circuit boards. Figure 6-8 Plug-in recepticle shows the connections brought out from the main frame of the 3300A for use with future plug-in units.



NOTES

1 COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
RESISTANCE IN OHMS
CAPACITANCE IN MICROFARADS

2 ▭ DENOTES FRONT PANEL MARKING

3 ⊏- - -⊐ DENOTES REAR PANEL MARKING

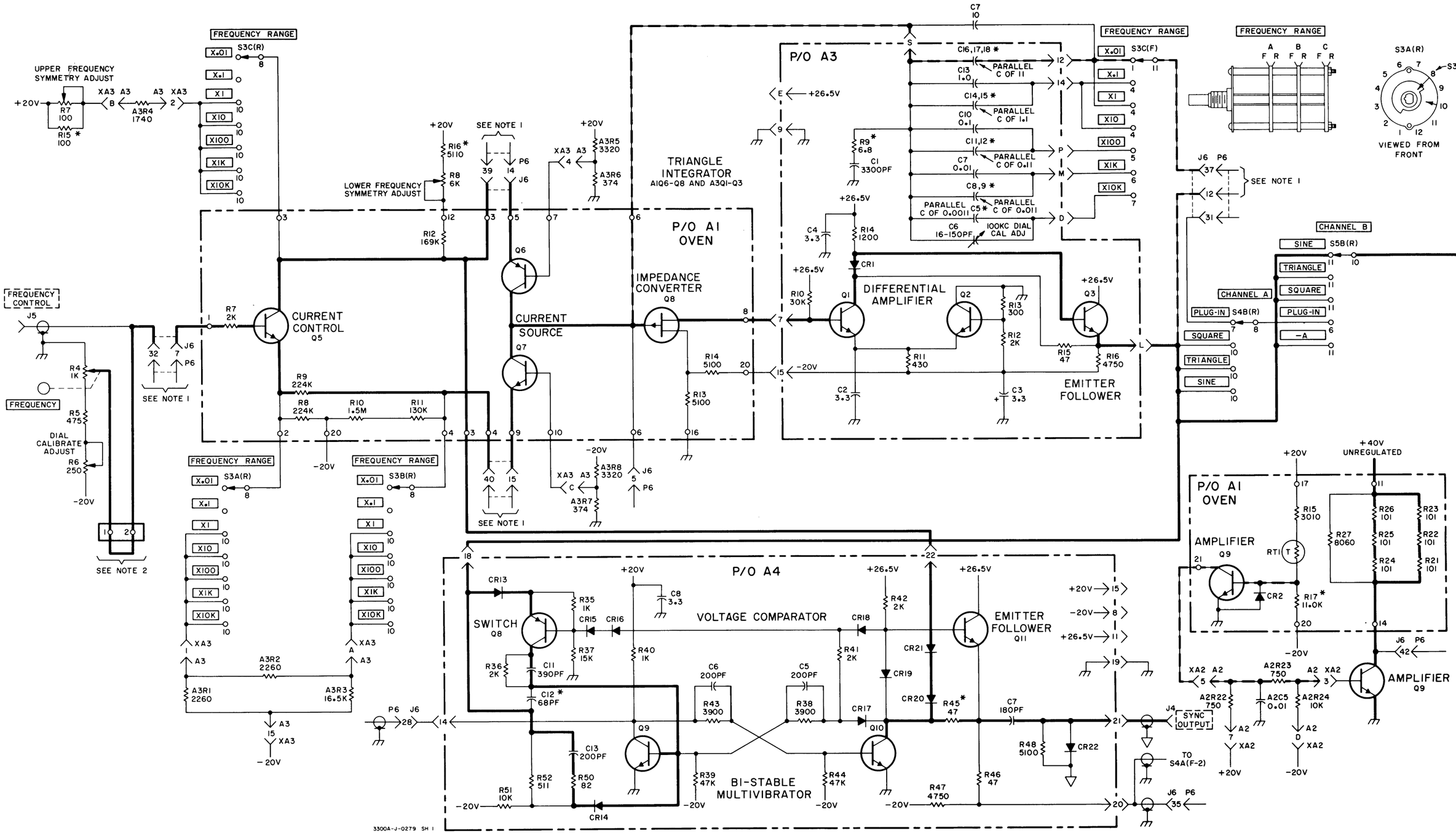
4 ≺ ≻ DENOTES SECOND APPEARANCE OF CONNECTOR

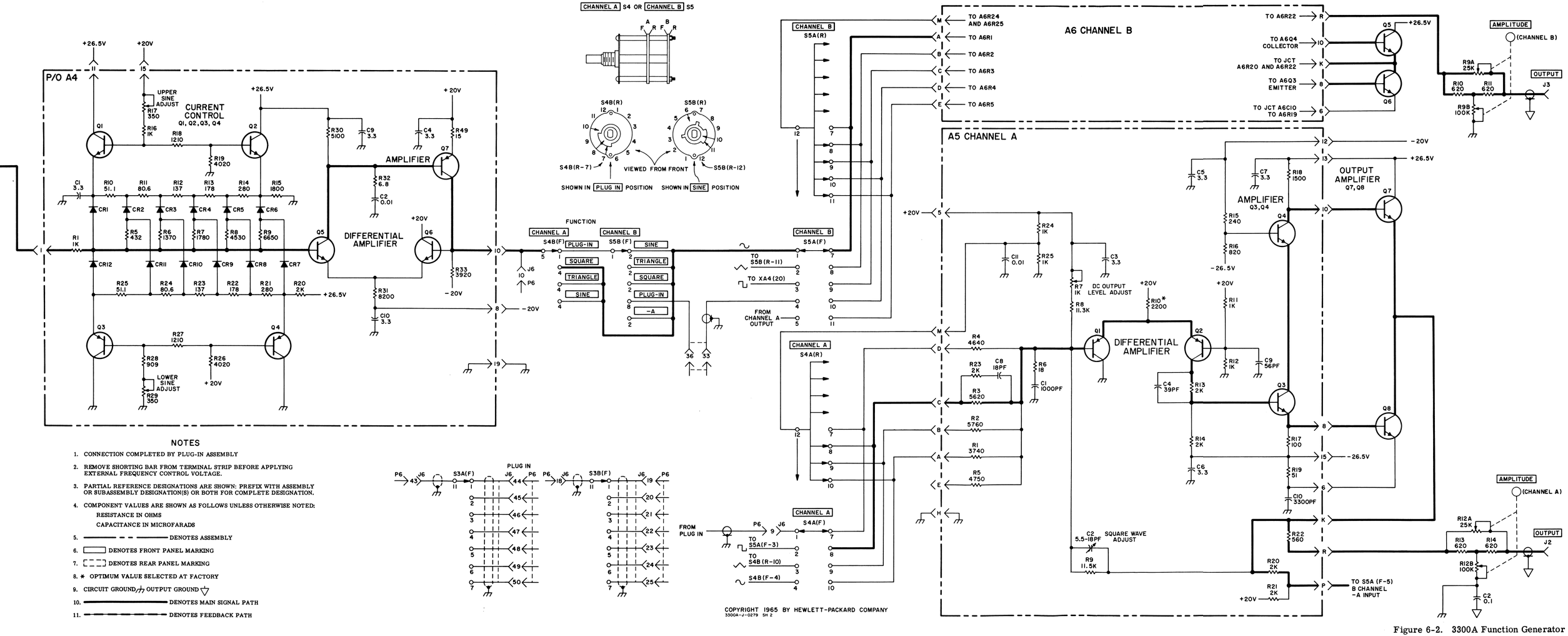
5 ⏚ CIRCUIT GROUND ⏚ POWER LINE GROUND

6 ——— DENOTES MAIN SIGNAL PATH

7 — — — — — DENOTES FEEDBACK PATH

Figure 6-1. 3300A Power Supply


FREQUENCY RANGE
X.01
X.1
X1
X10
X100
X1K
X10K
S3C(R)
S3C(F)
S3A(R)
S3A(R-8)
S3B(R)
S5B(R)
S4B(R)
A B C
F R F R F R
VIEWED FROM FRONT
UPPER FREQUENCY SYMMETRY ADJUST
+20V
R7 100
R15 * 100
A3R4 1740
XA3 A3
LOWER FREQUENCY SYMMETRY ADJUST
R16 * 5110
R8 6K
SEE NOTE 1
A3R5 3320
A3R6 374
R12 169K
TRIANGLE INTEGRATOR
A1Q6-Q8 AND A3Q1-Q3
P/O A1 OVEN
P/O A3
C7 10
C16,17,18 *
PARALLEL C OF 11
C13 1.0
C14,15 *
C10 0.1
PARALLEL C OF 1.1
C11,12 *
C7 0.01
PARALLEL C OF 0.11
C8,9 *
C5 *
PARALLEL C OF 0.0011
PARALLEL C OF 0.011
C6 16-150PF
100KC DIAL CAL ADJ
R9 * 6.8
C1 3300PF
+26.5V
C4 3.3
R14 1200
CR1
R10 30K
Q1
DIFFERENTIAL AMPLIFIER
Q2
Q3
R13 300
R12 2K
R15 47
R16 4750
R11 430
C2 3.3
C3 3.3
EMITTER FOLLOWER
-20V
J6 P6
SEE NOTE 1
CHANNEL B
SINE
TRIANGLE
SQUARE
PLUG-IN
-A
CHANNEL A
FREQUENCY CONTROL
J5
R4 1K
FREQUENCY
R5 475
DIAL CALIBRATE ADJUST
R6 250
SEE NOTE 2
R7 2K
CURRENT CONTROL Q5
CURRENT SOURCE
Q6
Q7
IMPEDANCE CONVERTER Q8
R9 224K
R8 224K
R10 1.5M
R11 130K
R14 5100
R13 5100
C8 3.3
SWITCH Q8
VOLTAGE COMPARATOR
EMITTER FOLLOWER Q11
BI-STABLE MULTIVIBRATOR
P/O A4
CR13
R35 1K
CR15
CR16
R37 15K
R40 1K
R36 2K
C11 390PF
C12 * 68PF
C6 200PF
C5 200PF
R43 3900
R38 3900
R41 2K
R42 2K
CR18
CR21
CR19
CR20
CR17
R45 * 47
C7 180PF
Q9
Q10
C13 200PF
R52 511
R50 82
R51 10K
CR14
R39 47K
R44 47K
R46 47
R47 4750
R48 5100
CR22
A3R1 2260
A3R2 2260
A3R3 16.5K
A3R8 3320
A3R7 374
TO S4A(F-2)
SYNC OUTPUT
P/O A1 OVEN
AMPLIFIER Q9
R15 3010
R27 8060
R26 101
R25 101
R24 101
R23 101
R22 101
R21 101
RT1
CR2
R17 * 11.0K
+40V UNREGULATED
A2R23 750
A2R22 750
A2C5 0.01
A2R24 10K
3300A-J-0279 SH 1



NOTES

1. CONNECTION COMPLETED BY PLUG-IN ASSEMBLY
2. REMOVE SHORTING BAR FROM TERMINAL STRIP BEFORE APPLYING EXTERNAL FREQUENCY CONTROL VOLTAGE.
3. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
4. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
5. ——— — — ——— DENOTES ASSEMBLY
6. ▭ DENOTES FRONT PANEL MARKING
7. ▭ DENOTES REAR PANEL MARKING
8. * OPTIMUM VALUE SELECTED AT FACTORY
9. CIRCUIT GROUND ⏚ OUTPUT GROUND ⏚
10. ——— DENOTES MAIN SIGNAL PATH
11. — — — — — DENOTES FEEDBACK PATH

Figure 6-2. 3300A Function Generator

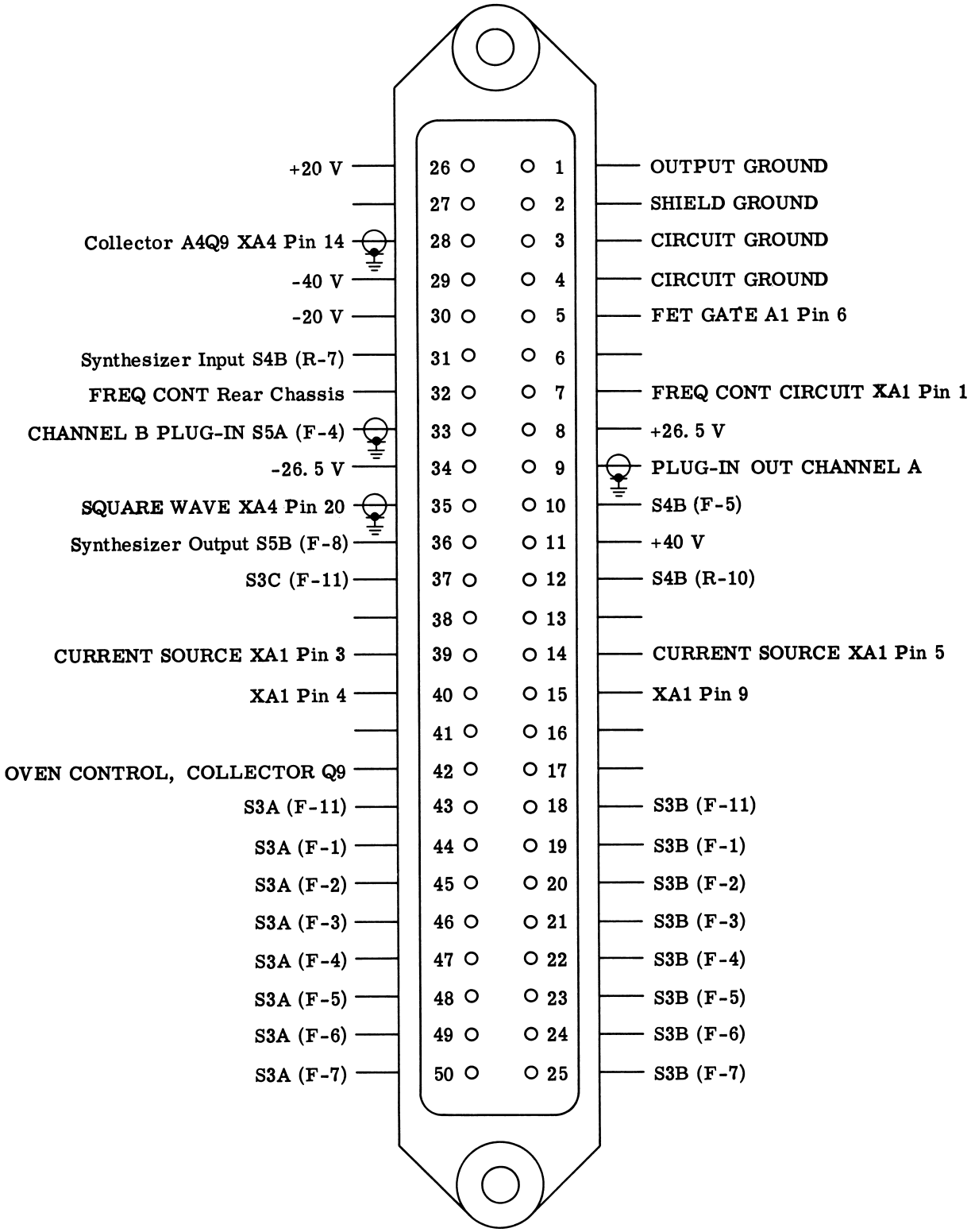


Figure 6-8. J6 Plug-in Receptacle

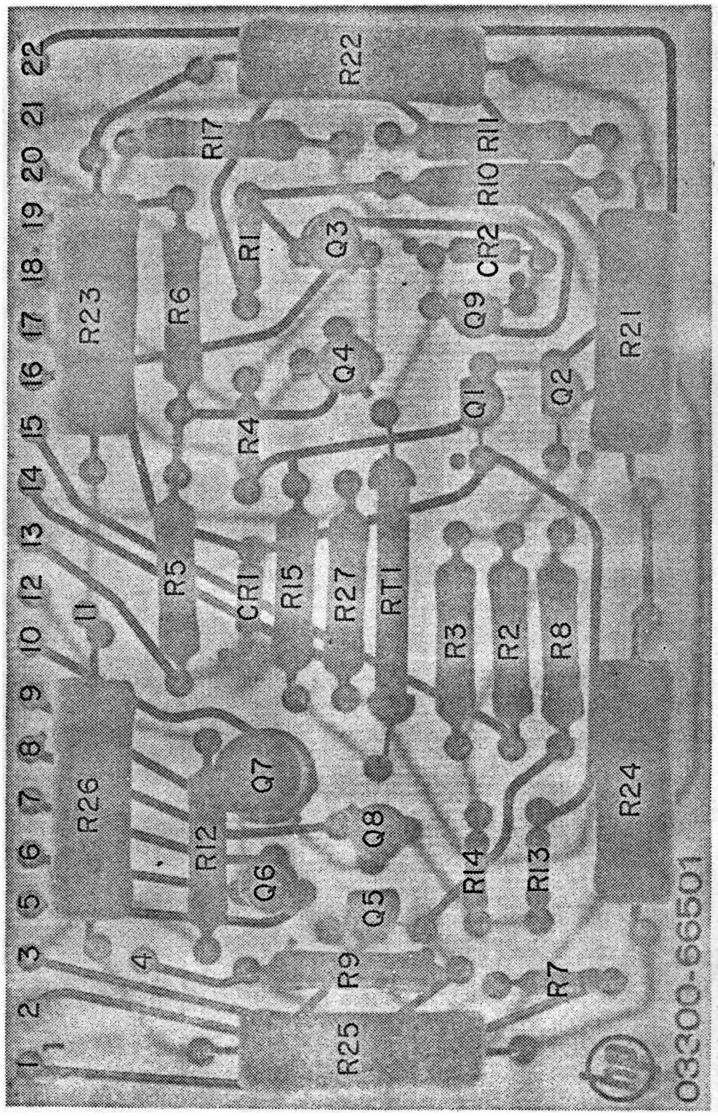

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
R26
R23
R6
R17
R22
R1
Q3
R10 R11
CR2
Q9
R21
Q4
Q1
Q2
R4
R5
CR1
R15
R27
RT1
R3
R2
R8
Q7
R12
Q6
Q8
Q5
R14
R13
R24
R9
R25
R7
03300-66501
3300A-A-0301

Figure 6-3.

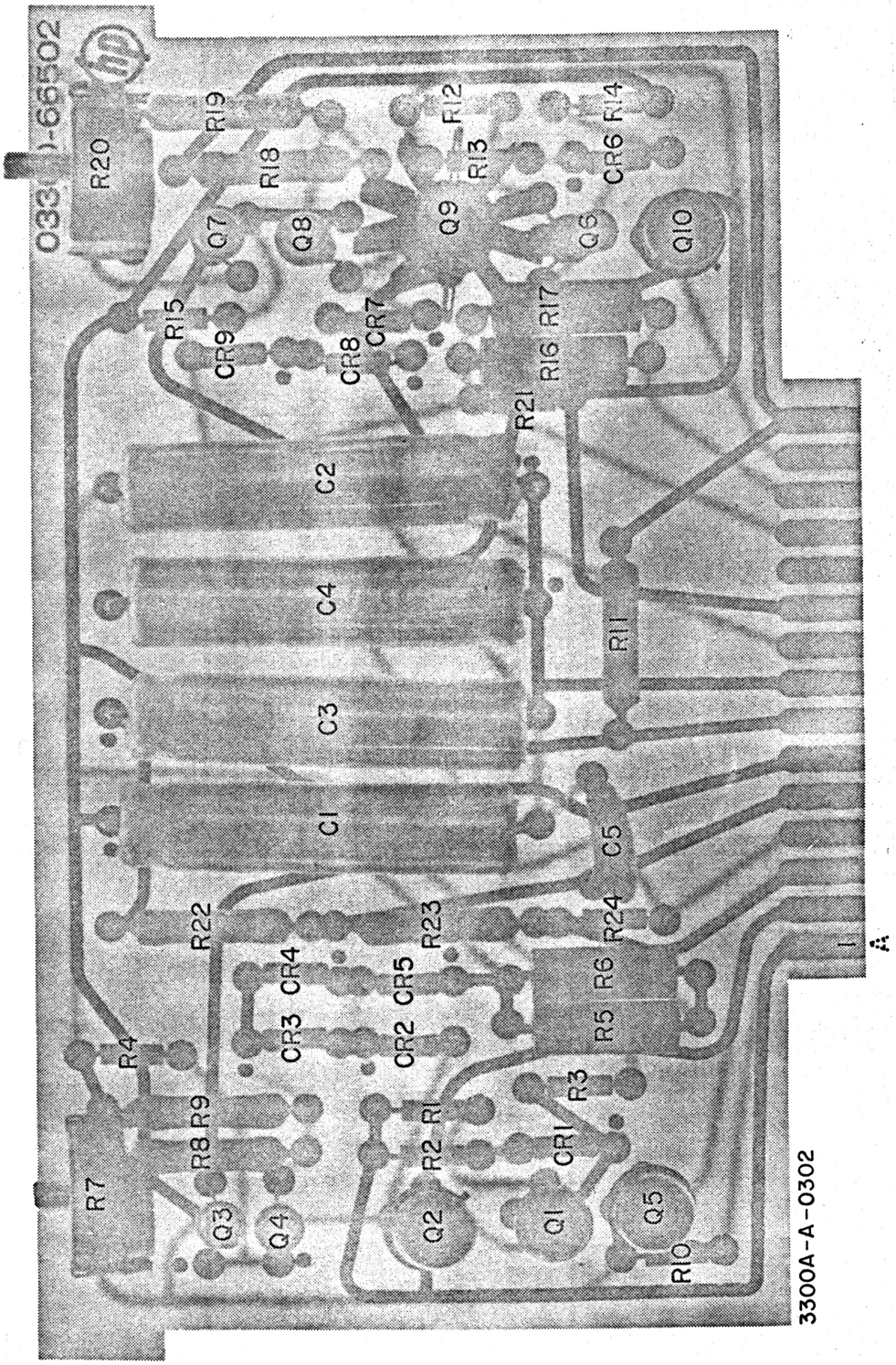

R20
R19
R18
R12
R13
R14
CR6
Q7
Q8
Q9
Q6
Q10
R15
CR9
CR8
CR7
R16
R17
R21
C2
C4
C3
C1
R11
C5
R22
R23
R24
CR4
CR5
CR3
CR2
R6
R5
R4
R8
R9
R1
R2
R3
CR1
R7
Q3
Q4
Q2
Q1
Q5
R10
3300A-A-0302

Figure 6-4

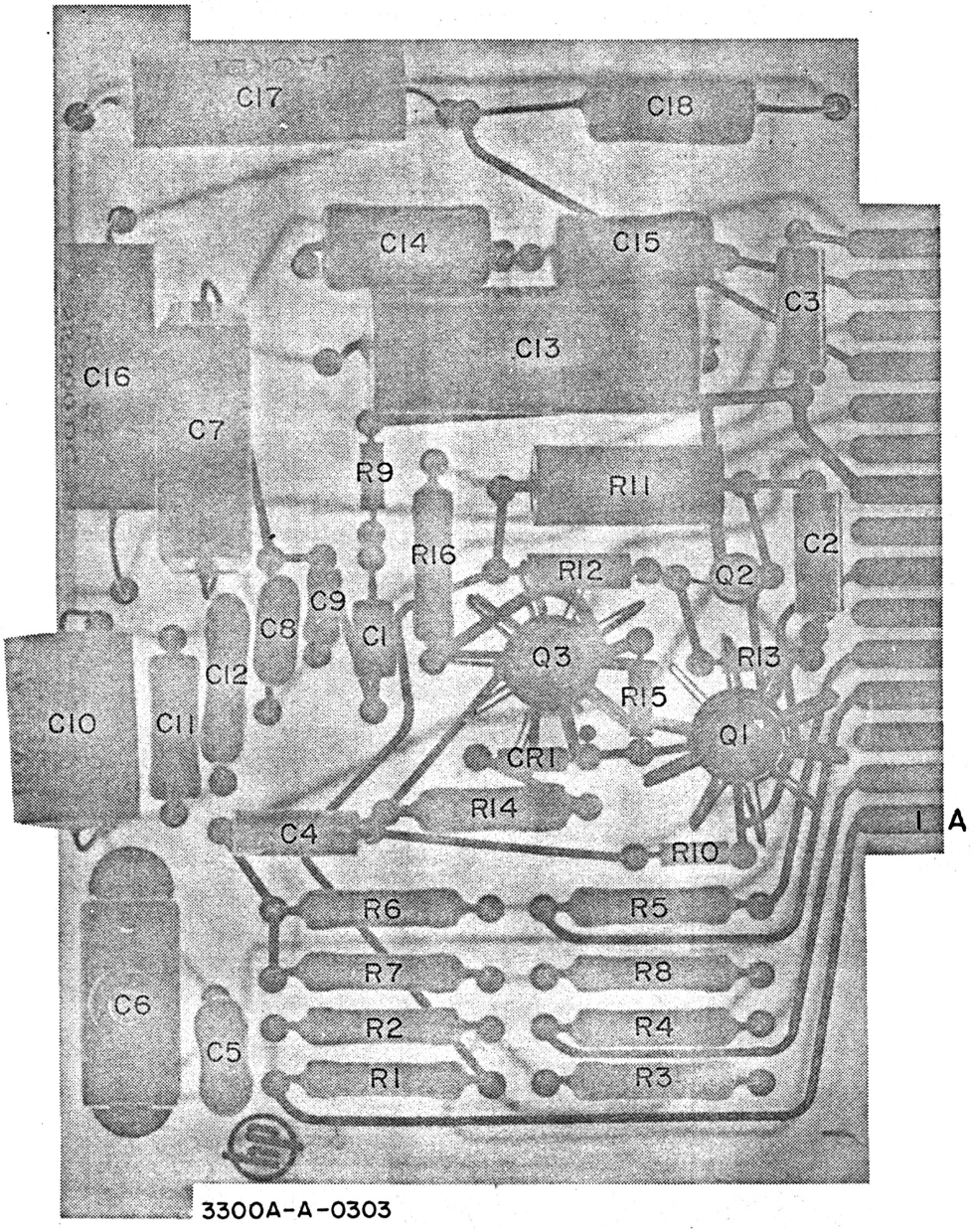

C17
C18
C14
C15
C3
C13
C16
C7
R9
R11
C2
R16
R12
Q2
C9
C8
C1
Q3
R13
C12
R15
C10
C11
Q1
CR1
R14
1 A
C4
R10
R6
R5
R7
R8
C6
R2
R4
C5
R1
R3
3300A-A-0303

Figure 6-5

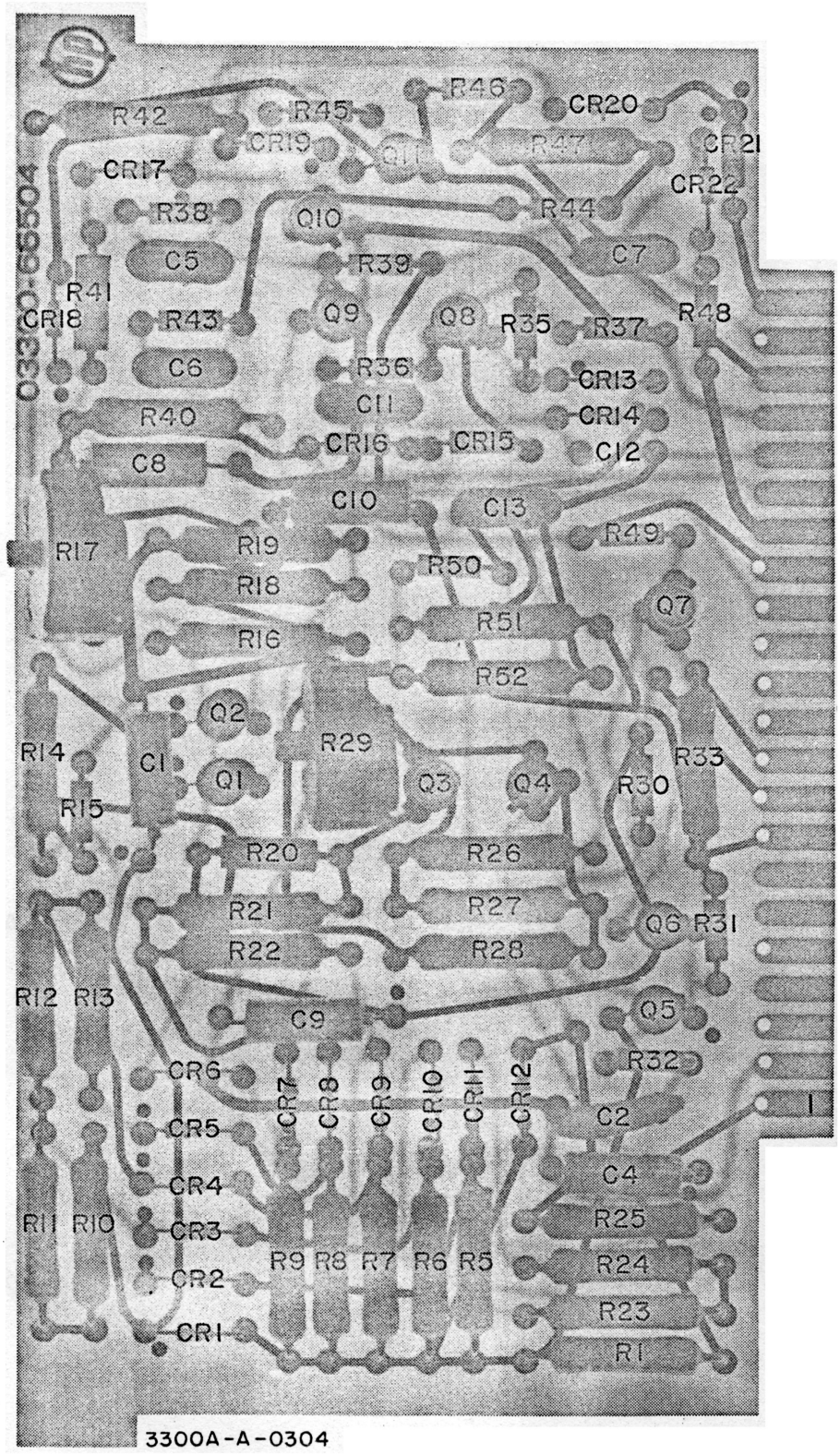

03300-65504
R42
R45
R46
CR20
CR19
Q11
R47
CR21
CR17
CR22
R38
Q10
R44
C5
R39
C7
R41
CR18
R43
Q9
Q8
R35
R37
R48
C6
R36
CR13
C11
CR14
R40
CR16
CR15
C12
C8
C10
C13
R49
R17
R19
R50
R18
Q7
R51
R16
R52
Q2
R29
R14
C1
Q1
Q3
Q4
R30
R33
R15
R20
R26
R21
R27
Q6
R31
R22
R28
R12
R13
C9
Q5
R32
CR6
CR7
CR8
CR9
CR10
CR11
CR12
C2
CR5
C4
CR4
R11
R10
CR3
R25
R9
R8
R7
R6
R5
R24
CR2
R23
CR1
R1
3300A-A-0304

Figure 6-6

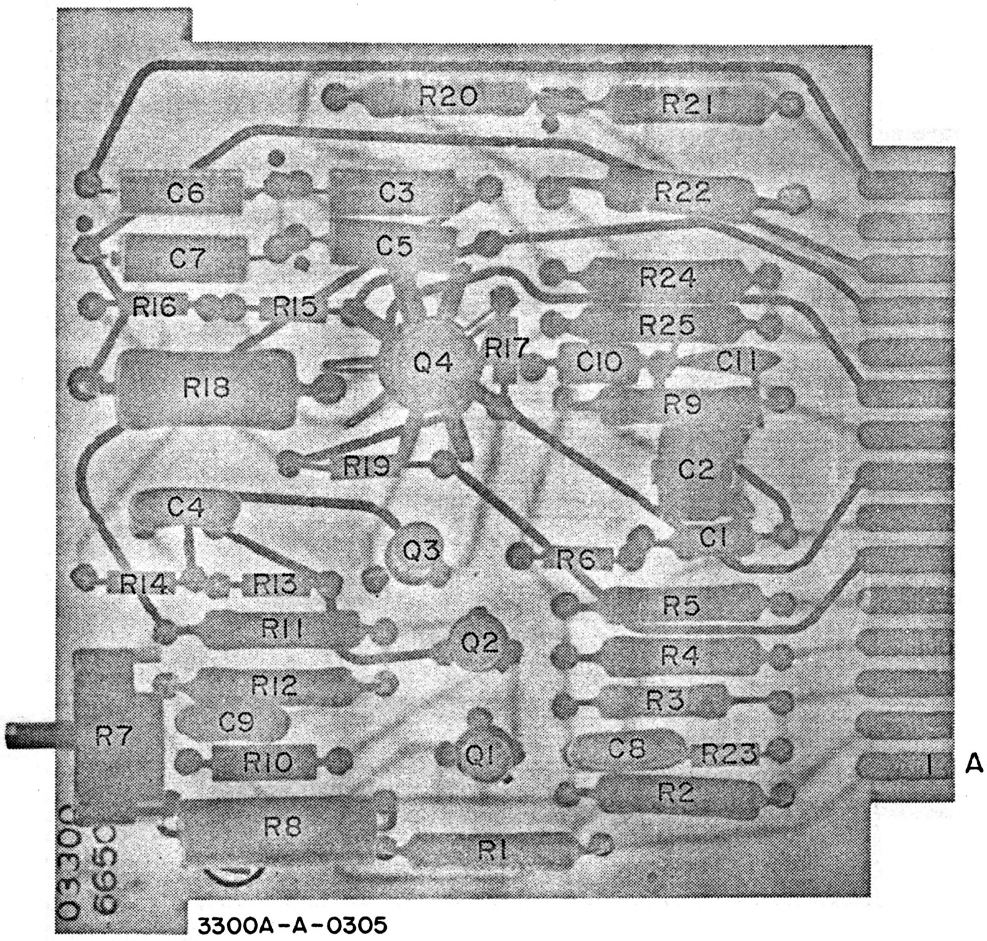

R20
R21
C6
C3
R22
C7
C5
R24
R16
R15
R25
Q4
R17
C10
C11
R18
R9
R19
C2
C4
Q3
R6
C1
R14
R13
R5
R11
Q2
R4
R12
R3
C9
R7
C8
R23
A
R10
Q1
R2
R8
R1
03300
6650
3300A-A-0305

Figure 6-7

SECTION VII
REPLACEABLE PARTS

7-1. INTRODUCTION.

7-2. This section contains information for ordering replacement parts. Table 7-1 lists parts in alphameric order of their reference designators and indicates the description and -hp- part number of each part, together with any applicable notes. Table 7-2 lists parts in alphameric order of their -hp- part number and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code (see Appendix A for list of manufacturers).

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column).

7-3. Miscellaneous parts are listed at the end of Table 7-1.

7-4. ORDERING INFORMATION.

7-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see Appendix B for office locations). Identify parts by their Hewlett-Packard part numbers.

7-6. NON-LISTED PARTS.

7-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell etc.
B	= motor	FL	= filter	Q	= transistor		
BT	= battery	HR	= heater	QCR	= transistor-diode	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CR	= diode	K	= relay	RT	= thermistor	XDS	= lampholder
DL	= delay line	L	= inductor	S	= switch	XF	= fuseholder
DS	= lamp	M	= meter	T	= transformer		
E	= misc electronic part	MP	= mechanical part	TC	= thermocouple	Z	= network

ABBREVIATIONS

Ag	= silver	ID	= inside diameter	ns	= nanosecond (s) = 10^{-9}	SPDT	= single-pole double-throw
Al	= aluminum	impg	= impregnated	nsr	= not separately replaceable	SPST	= single-pole single-throw
amp	= ampere (s)	incd	= incandescent				
Au	= gold	ins	= insulation (ed)				
				obd	= order by description	Ta	= tantalum
C	= capacitor	K	= kilohm (s) = 10^{+3}	OD	= outside diameter	TiO_2	= titanium dioxide
cer	= ceramic	Kc	= kiloycycle (s) = 10^{+3}			tog	= toggle
coef	= coefficient			p	= peak	tol	= tolerance
com	= common	L	= inductor	pc	= printed circuit	trim	= trimmer
comp	= composition	lin	= linear taper	pf	= picofarad (s) = 10^{-12}	TSTR	= transistor
conn	= connection	log	= logarithmic taper	piv	= peak inverse voltage		
cps	= cycles per second	m	= milli = 10^{-3}	pos	= position (s)	v	= volt (s)
dep	= deposited	ma	= milliampere (s) = 10^{-3}	poly	= polystyrene	vacw	= alternating current working volt (s)
DPDT	= double-pole double-throw	Mc	= megacycle (s) = 10^{+6}	pot	= potentiometer	var	= variable
DPST	= double-pole single-throw	meg	= megohm (s) = 10^{+6}	p-p	= peak-to-peak	vdcw	= direct current working volt (s)
elect	= electrolytic	met film	= metal film	prec	= precision (temperature coefficient, long term stability, and/or tolerance)		
encap	= encapsulated	mfr	= manufacturer			w	= watt (s)
f	= farad (s)	mtg	= mounting			w/	= with
FET	= field effect transistor	μ	= micro = 10^{-6}			wiv	= reverse working voltage
fxd	= fixed	my	= mylar	R	= resistor	w/o	= without
GaAs	= gallium arsenide			Rh	= rhodium	ww	= wirewound
Gc	= gigacycle (s) = 10^{+9}	na	= nanoampere (s) = 10^{-9}	rms	= root-mean-square	*	= optimum value selected at factory, average value shown (part may be omitted)
gd	= guard (ed)	NC	= normally closed	rot	= rotary		
Ge	= germanium	Ne	= neon				
grd	= ground (ed)	NO	= normally open	Se	= selenium	**	= no standard type number assigned (selected or special type)
h	= henry (ies)	NPO	= negative positive zero (zero temperature coefficient)	sect	= section (s)		
Hg	= mercury			Si	= silicon		
				sl	= slide		

Table 7-1. Reference Designation Index

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A1	03300-66501	Oven board assembly, includes: A1CR1 and A1CR2 A1Q1 thru A1Q9 A1R1 thru A1R27 and A1RT1	
A1CR1	1902-3182	Diode: zener breakdown 12. 1 v ±5% 400 mw	
A1CR2	1901-0025	Diode: Si junction 100 ma at 1 v 100 piv 12 pf	
A1Q1 and A1Q2	1854-0081	Transistor: Si NPN **	
A1Q3 and A1Q4	1853-0009	Transistor: Si PNP **	
A1Q5	1854-0081	Transistor: Si NPN **	
A1Q6	1853-0010	Transistor: Si PNP **	
A1Q7	1854-0003	Transistor: Si NPN **	
A1Q8	1855-0004	Transistor: FET P Channel**	
A1Q9	1854-0081	Transistor: Si NPN **	
A1R1	0757-0442	R: fxd prec met flm 10 K ±1% 1/8 w	
A1R2	0757-0190	R: fxd prec met flm 20 K ±1% 1/2 w	
A1R3	0757-1085	R: fxd prec met flm 21 K ±1% 1/2 w	
A1R4	0757-0442	R: fxd prec met flm 10 K ±1% 1/8 w	
A1R5	0698-3413	R: fxd prec met flm 13. 3 K ±1% 1/2 w	
A1R6	0757-0190	R: fxd prec met flm 20 K ±1% 1/2 w	
A1R7	0757-0283	R: fxd prec met flm 2000 ohms ±1% 1/8 w	
A1R8 and A1R9	0698-3482	R: fxd prec 224 K ±1/4% 1/2 w	
A1R10	0698-3355	R: fxd prec met flm 1. 5 meg ±1/4% 1/2 w	
A1R11	0757-0861	R: fxd prec met flm 130 K ±1% 1/2 w	
A1R12	0757-0066	R: fxd prec met flm 169 K ±1% 1/2 w	
A1R13 and A1R14	0757-0483	R: fxd prec met flm 5100 ohms ±1% 1/8 w	
A1R15	0757-0828	R: fxd prec met flm 3010 ohms ±1% 1/2 w	
A1R16		Not Assigned	
A1R17*	0757-0840	R: fxd prec met flm 11 K ±1% 1/2 w	
A1R18 thru A1R20		Not Assigned	
A1R21 thru A1R26	0766-0025	R: fxd met flm 101 ohms ±2% 3 w	
A1R27	0698-3481	R: fxd prec met flm 8060 ohms ±1% 1/2 w	
A1RT1	0839-0012	Thermistor: 50 K ±10%	
A2	03300-66502	Power supply board assembly, includes: A2C1 thru A2C5 A2CR1 thru A2CR9 A2Q1 thru A2Q10 A2R1 thru A2R24	
A2C1 thru A2C4	0180-0149	C: fxd Al elect 65 μf +100% -10% 60 vdcw	
A2C5	0150-0012	C: fxd disc cer durez coated 0. 01 μf ±20% 1000 vdcw	
A2CR1 thru A2CR9	1901-0025	Diode: Si junction 100 ma at + 1 v 100 piv 12 pf	

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A2Q1	1853-0016	Transistor: Si PNP 2N3638	
A2Q2	1854-0039	Transistor: Si NPN 2N3053	
A2Q3 and A2Q4	1854-0033	Transistor: Si NPN 2N3391	
A2Q5	1854-0039	Transistor: Si NPN 2N3053	
A2Q6	1854-0033	Transistor: Si NPN 2N3391	
A2Q7 and A2Q8	1853-0009	Transistor: Si PNP **	
A2Q9	1853-0001	Transistor: Si PNP **	
	1205-0033	Heat dissipator-semiconductor for A2Q9	
A2Q10	1853-0009	Transistor: Si PNP **	
A2R1 and A2R2	0683-2025	R: fxd comp 2000 ohms ±5% 1/4 w	
A2R3	0683-3035	R: fxd comp 39 K ±5% 1/4 w	
A2R4	0683-6825	R: fxd comp 6800 ohms ±5% 1/4 w	
A2R5 and A2R6	0689-0275	R: fxd comp 2.7 ohms ±5% 1 w	
A2R7	2100-0865	R: var comp lin 350 ohms ±30% 1/8 w	
A2R8	0698-3341	R: fxd prec met flm 1910 ohms ±1% 1/2 w	
A2R9	0757-0824	R: fxd prec met flm 2000 ohms ±1% 1/2 w	
A2R10	0683-3625	R: fxd comp 3600 ohms ±5% 1/4 w	
A2R11	0698-3478	R: fxd prec met flm 806 ohms ±1% 1/2 w	
A2R12	0683-2025	R: fxd comp 2000 ohms ±5% 1/4 w	
A2R13	0683-2425	R: fxd comp 2400 ohms ±5% 1/4 w	
A2R14	0683-3035	R: fxd comp 39 K ±5% 1/4 w	
A2R15	0683-8225	R: fxd comp 8200 ohms ±5% 1/4 w	
A2R16 and A2R17	0689-0275	R: fxd comp 2.7 ohms ±5% 1 w	
A2R18	0757-0824	R: fxd prec met flm 2000 ohms ±1% 1/2 w	
A2R19	0757-0085	R: fxd prec met flm 4020 K ±1% 1/2 w	
A2R20	2100-1434	R: var pot comp lin 1000 ohms ±30% 1/8 w	
A2R21	0683-3625	R: fxd comp 3600 ohms ±5% 1/4 w	
A2R22 and A2R23	0757-0817	R: fxd prec met flm 750 ohms ±1% 1/2 w	
A2R24	0683-1035	R: fxd comp 10 K ±5% 1/4 w	
A3	03300-66503	Integrator board assembly, includes: A3C1 thru A3C18 A3CR1 A3Q1 thru A3Q3 A3R1 thru A3R16	
A3C1	0160-0155	C: fxd 3300 pf ±10%	
A3C2 thru A3C4	0180-0161	C: fxd Ta elect 3.3 μf ±20% 35 vdcw	
A3C5*	0160-0945	C: fxd	
A3C6	0131-0004	C: var mica 16 - 150 pf 175 vdcw	
A3C7	0170-0029	C: fxd poly 0.01 μf ±10% 50 vdcw	
A3C8*and A3C9*		C: fxd	
A3C10	0170-0022	C: fxd my 0.1 μf ±10% 600 vdcw	
A3C11*and A3C12*		C: fxd	
A3C13	0160-0859	C: fxd my 1 μf ±10% 50 vdcw	
A3C14* thru A3C18*		C: fxd	

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A3CR1	1901-0025	Diode: Si junction 100 ma at +1 v 100 piv 12 pf	
A3Q1	1854-0039	Transistor: Si NPN 2N3053	
A3Q2	1854-0033	Transistor: Si NPN 2N3391	
A3Q3	1854-0039	Transistor: Si NPN 2N3053	
A3R1 and A3R2	0811-1548	R: fxd prec 2260 ohms ±1/4% 1/3 w	
A3R3	0811-1550	R: fxd prec ww 16. 5 K ±1/4% 2/3 w	
A3R4	0811-1547	R: fxd prec ww 1740 ohms ±1/4% 1/3 w	
A3R5	0811-1549	R: fxd prec ww 3320 ohms ±1/4% 1/3 w	
A3R6 and A3R7	0811-1546	R: fxd prec ww 374 ohms ±1/4% 1/3 w	
A3R8	0811-1549	R: fxd prec ww 3320 ohms ±1/4% 1/3 w	
A3R9*	0683-0685	R: fxd comp 6. 8 ohms ±5% 1/4 w	
A3R10	0683-3035	R: fxd comp 30 K ±5% 1/4 w	
A3R11	0764-0024 1205-0033	R: fxd met oxide flm 430 ohms ±5% 2 w Heat dissipator-semiconductor for A3R11	
A3R12	0686-2025	R: fxd comp 2000 ohms ±5% 1/2 w	
A3R13	0683-3015	R: fxd comp 300 ohms ±5% 1/4 w	
A3R14	0761-0009	R: fxd met oxide flm 1200 ohms ±5% 1 w	
A3R15	0683-4705	R: fxd comp 47 ohms ±5% 1/4 w	
A3R16	0757-0832	R: fxd prec met flm 4750 ohms ±1% 1/2 w	
A4	03300-66504	Shaper comparator board assembly, includes: A4C1 thru A4C13 A4CR1 thru A4CR22 A4Q1 thru A4Q11 A4R1 thru A4R51	
A4C1	0180-0161	C: fxd Ta elect 3. 3 μf ±20% 35 vdcw	
A4C2	0150-0012	C: fxd cer 0.01 μf ±20% 1000 vdcw	
A4C3		Not Assigned	
A4C4	0180-0161	C: fxd Ta elect 3. 3 μf ±20% 35 vdcw	
A4C5 and A4C6	0140-0198	C: fxd mica 200 pf ±5%	
A4C7	0140-0197	C: fxd mica 180 pf ±5%	
A4C8 thru A4C10	0180-0161	C: fxd Ta elect 3. 3 μf ±20% 35 vdcw	
A4C11	0140-0200	C: fxd mica 390 pf ±5%	
A4C12*	0160-0376	C: fxd 68 pf ±5%	
A4C13	0140-0198	C: fxd mica 200 pf ±5%	
A4CR1 thru A4CR14	1901-0040	Diode: Si 30 ma at+1 v 30 piv 2 pf 2 ns	
A4CR15 and A4CR16	1901-0025	Diode: Si junction 100 ma at +1 v 100 piv 12 pf	
A4CR17 and A4CR18	1901-0040	Diode: Si 30 ma at +1 v 30 piv 2 pf 2 ns	
A4CR19	1901-0025	Diode: Si junction 100 ma at +1 v 100 piv 12 pf	
A4CR20	1901-0040	Diode: Si 30 ma at +1 v 30 piv 2 pf 2 ns	
A4CR21	1901-0033	Diode: Si 100 ma at +1 v 13 pf 180 wiv	
A4CR22	1901-0040	Diode: Si 30 ma at +1 v 30 piv 2 pf 2 ns	
A4Q1 and A4Q2	1854-0033	Transistor: Si NPN 2N3391	
A4Q3 and A4Q4	1853-0009	Transistor: Si PNP **	

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A4Q5 and A4Q6	1854-0033	Transistor: Si NPN 2N3391	
A4Q7 and A4Q8	1853-0009	Transistor: Si PNP **	
A4Q9 and A4Q10	1854-0005	Transistor: Si NPN 2N708	
A4Q11	1854-0033	Transistor: Si NPN 2N3391	
A4R1	1757-0159	R: fxd prec met flm 1000 ohms ±1% 1/2 w	
A4R2, A4R3 and A4R4		Not Assigned	
A4R5	0757-0812	R: fxd prec met flm 432 ohms ±1% 1/2 w	
A4R6	0698-3337	R: fxd prec met flm 1370 ohms ±1% 1/2 w	
A4R7	0698-0089	R: fxd prec met flm 1780 ohms ±1% 1/2 w	
A4R8	0698-3347	R: fxd prec met flm 4530 ohms ±1% 1/2 w	
A4R9	0698-3350	R: fxd prec met flm 6650 ohms ±1% 1/2 w	
A4R10	0757-1000	R: fxd prec met flm 51. 1 ohms ±1% 1/2 w	
A4R11	0698-3332	R: fxd prec met flm 80. 6 ohms ±1% 1/2 w	
A4R12	0698-3333	R: fxd prec met flm 137 ohms ±1% 1/2 w	
A4R13	0698-3334	R: fxd prec met flm 178 ohms ±1% 1/2 w	
A4R14	0757-1091	R: fxd prec met flm 280 ohms ±1% 1/2 w	
A4R15	0683-1825	R: fxd comp 1800 ohms ±5% 1/4 w	
A4R16	0757-0159	R: fxd prec met flm 1000 ohms ±1% 1/2 w	
A4R17	2100-0865	R: var comp lin 350 ohms ±30% 1/8 w	
A4R18	0757-0821	R: fxd prec met flm 1210 ohms ±1% 1/2 w	
A4R19	0757-0085	R: fxd prec met flm 4020 ohms ±1% 1/2 w	
A4R20	0686-2025	R: fxd comp 2000 ohms ±5% 1/2 w	
A4R21	0757-1091	R: fxd prec met flm 280 ohms ±1% 1/2 w	
A4R22	0698-3334	R: fxd prec met flm 178 ohms ±1% 1/2 w	
A4R23	0698-3333	R: fxd prec met flm 137 ohms ±1% 1/2 w	
A4R24	0698-3332	R: fxd prec met flm 80. 6 ohms ±1% 1/2 w	
A4R25	0757-1000	R: fxd prec met flm 51. 1 ohms ±1% 1/2 w	
A4R26	0757-0085	R: fxd prec met flm 4020 ohms ±1% 1/2 w	
A4R27	0757-0821	R: fxd prec met flm 1210 ohms ±1% 1/2 w	
A4R28	0757-0819	R: fxd prec met flm 909 ohms ±1% 1/2 w	
A4R29	2100-0856	R: var lin 350 ohms ±30% 1/8 w	
A4R30	0683-5125	R: fxd comp 5100 ohms ±5% 1/4 w	
A4R31	0683-8225	R: fxd comp 8200 ohms 1/4 w	
A4R32	0683-0685	R: fxd comp 6. 8 ohms ±5% 1/4 w	
A4R33	0757-0830	R: fxd prec met flm 3920 ohms ±1% 1/2 w	
A4R34		Not Assigned	
A4R35	0683-1025	R: fxd comp 1000 ohms ±5% 1/4 w	
A4R36	0683-2025	R: fxd comp 2000 ohms ±5% 1/4 w	
A4R37	0683-1535	R: fxd comp 15 K ±5% 1/4 w	
A4R38	0683-3025	R: fxd comp 3900 ohms ±5% 1/4 w	
A4R39	0683-4735	R: fxd comp 47 K ±5% 1/4 w	
A4R40	0757-0159	R: fxd prec met flm 1000 ohms ±1% 1/2 w	
A4R41	0686-2025	R: fxd comp 2000 ohms ±5% 1/2 w	
A4R42	0757-0824	R: fxd prec met flm 2000 ohms ±1% 1/2 w	
A4R43	0683-3925	R: fxd comp 3900 ohms ±5% 1/4 w	
A4R44	0683-4735	R: fxd comp 47 K ±5% 1/4 w	
A4R45*		R: fxd	
A4R46	0683-4705	R: fxd comp 47 ohms ±5% 1/4 w	

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A4R47	0757-0832	R: fxd prec met flm 4750 ohms ±1% 1/2 w	
A4R48	0686-5125	R: fxd comp 5100 ohms ±5% 1/4 w	
A4R49	0683-1505	R: fxd comp 15 ohms ±5% 1/4 w	
A4R50	0683-8205	R: fxd comp 82 ohms ±5% 1/4 w	
A4R51	0757-0839	R: fxd prec met flm 10 K ±1% 1/2 w	
A4R52	0757-0819	R: fxd prec met flm 511 ohms ±1% 1/2 w	
A5	03300-66505	Amplifier board assembly, includes: A5C1 thru A5C11 A5Q1 thru A5Q4 A5R1 thru A5R25	
	03300-26501	Pc board blank	
A5C1	0160-0153	C: fxd 0.001 µf ±10%	
A5C2	0121-0036	C: var 5.5 pf to 18 pf	
A5C3	0180-0161	C: fxd Ta elect 3.3 µf ±20% 35 vdcw	
A5C4	0140-0190	C: fxd mica 39 pf ±5%	
A5C5, A5C6 and A5C7	0180-0161	C: fxd Ta elect 3.3 µf ±20% 35 vdcw	
A5C8	0160-0356	C: fxd mica 18 pf ±5%	
A5C9	0140-0191	C: fxd mica 56 pf ±5%	
A5C10	0160-0155	C: fxd 3300 pf ±10%	
A5C11	0150-0093	C: fxd cer durez coated 0.01 µf +80% -20% 100 vdcw	
A5Q1 and A5Q2	1853-0009	Transistor: Si PNP **	
A5Q3	1854-0005	Transistor: Si NPN 2N708	
A5Q4	1854-0039	Transistor: Si NPN 2N3053	
A5R1	0698-3480	R: fxd prec met flm 3740 ohms ±1% 1/2 w	
A5R2	0698-3349	R: fxd prec met flm 5760 ohms ±1% 1/2 w	
A5R3	0757-0834	R: fxd prec met flm 5620 ohms ±1% 1/2 w	
A5R4	0698-3348	R: fxd prec met flm 4640 ohms ±1% 1/2 w	
A5R5	0757-0832	R: fxd prec met flm 4750 ohms ±1% 1/2 w	
A5R6	0683-1805	R: fxd comp 18 ohms ±5% 1/4 w	
A5R7	2100-1434	R: var lin 1000 ohms ±3% 1/8 w	
A5R8	0757-0041	R: fxd prec met flm 11.3 K ±1% 1/2 w	
A5R9	0698-3352	R: fxd prec met flm 11.5 K ±1% 1/2 w	
A5R10*	0686-2225	R: fxd comp 2200 ohms ±5% 1/2 w	
A5R11 and A5R12	0757-0159	R: fxd prec met flm 1000 ohms ±1% 1/2 w	
A5R13 and A5R14	0683-2025	R: fxd comp 2000 ohms 1/4 w	
A5R15	0683-2415	R: fxd comp 240 ohms ±5% 1/4 w	
A5R16	0683-8215	R: fxd comp 820 ohms ±5% 1/4 w	
A5R17	0683-1015	R: fxd comp 100 ohms ±5% 1/4 w	
A5R18	0698-3338	R: fxd met oxide 1500 ohms ±5% 2 w	
A5R19	0683-5105	R: fxd comp 51 ohms ±5% 1/4 w	
A5R20 and A5R21	0698-3342	R: fxd prec met flm 2000 ohms ±1/4% 1/2 w	
A5R22	0761-0057 1205-0033	R: fxd met oxide flm 560 ohms ±5% 1 w Heat dissipator-semiconductor for A5R22	
A5R23	0683-2025	R: fxd comp 2000 ohms ±5% 1/4 w	
A5R24 and A5R25	0757-0159	R: fxd prec met flm 1000 ohms ±1% 1/2 w	
A6	03300-66505	Amplifier board assembly (Components same as A5 board)	

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
C1	0150-0119	C: fxd 0.01 2 section μf 250 vacw	
C2	0170-0022	C: fxd my 0.1 μf ±20% 600 vdcw	
C3	0160-0195	C: fxd cer 1000 pf ±20% 250 vacw	
C4		Not Assigned	
C5 and C6	0180-0056	C: fxd elect 1000 μf 50 vdcw	
C7	0160-2050	C: fxd my 10 μf ±10% 30 vdcw	
CR1 thru CR4	1901-0026	Diode: Si 200 piv	
F1	2110-0007	Fuse: cartridge slow-blow 1 amp 125 v	
J1	1251-1009	Connector: ac power cord receptacle	
J2 thru J5	1250-0118	Connector: BNC UG-1094 A/U	
J6	1251-0101	Connector: 50 Pin	
Q1 and Q2	1854-0072	Transistor: Si NPN 2N3054	
Q3 thru Q9	1854-0039	Transistor: Si NPN 2N3053	
R1	0683-3335	R: fxd comp 33 K ±5% 1/4 w	
R2	2100-0261	R: var lin 2000 ohms ±20% 3/10 w	
R3	2100-0299	R: var lin 3000 ohms ±20% 3/10 w	
R4	2100-1563	R: var ww freq control 1000 ohms ±5% 3 w	
R5	0698-3336	R: fxd prec met flm 475 ohms ±1% 1/2 w	
R6	2100-0809	R: var lin 250 ohms ±30% 3/10 w	
R7	2100-0118	R: var lin 100 ohms ±20% 3/10 w	
R8	2100-0136	R: var lin 6000 ohms ±20% 3/10 w	
R9	2100-1548	R: var comp molded Carbon attenuator 600 ohms ±20% 5w	
R10 and R11	0686-6215	R: fxd comp 620 ohms ±5% 1/2 w	
R12	2100-1548	R: var comp molded Carbon attenuator 600 ohms ±20% 5w	
R13 and R14	0686-6215	R: fxd comp 620 ohms ±5% 1/2 w	
R15*	0757-0178	R: fxd prec met flm 100 ohms ±1% 1/4 w	
R16*	0757-0833	R: fxd prec met flm 5100 ohms ±1% 1/2 w	
S1	3101-0100	Switch: pushbutton lighted SPDT 2 amp at 125 vacw	
S2	3101-0033	Switch: slide DPDT non-shorting 0.5 amp 125 vdcw 3 amp at 125 vacw	
S3	3100-1709	Switch: rotary (RANGE)	
S4	3100-0710	Switch: rotary (function CHANNEL A)	
S5	3100-1711	Switch: rotary (function CHANNEL B)	
T1	9100-1306	Transformer: power	
W1	8120-0078	Cable: ac power 7.5 feet long	
XA1		Not Assigned	
XA2 and XA3	1251-0159	Connector: 30 pin double readout	
XA4	1251-0208	Connector: 22 pin pc (fork type contacts)	
XA5 and XA6	1251-0159	Connector: 30 pin double readout	

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
		MISCELLANEOUS	
	5060-0775	Accessory: 5" rack mount kit	
	03300-46902	Cabinet: oven assembly	
	5060-0751	Cover: assembly bottom	
	5060-0739	Cover: assembly top	
	03300-00605	Cover: chassis bottom	
	03300-00607	Cover: chassis top	
	5000-0733	Cover: front side	
	03300-46904	Cover: oven	
	03300-00606	Cover: panel rear	
	5000-0732	Cover: rear side	
	03300-04001	Dial: frequency main (FREQUENCY)	
	5020-0630	Dial: hub (FREQUENCY)	
	2950-0039	Extension: nut hexagonal 9/16"	
	5060-0767	Foot assembly: full module	
	1400-0084	Fuse holder: extractor post type for single 3AG cartridge	
	5060-0222	Handle assembly: side	
	5040-0619	Insulator: panel connector	
	3050-0159	Insulator: washer #6 nylon	
	0370-0160	Knob: dial round 1 5/8" diam black (DIAL)	
	0370-0025	Knob: 3/4" diam (VERNIER)	
	0370-0077	Knob: 5/8" skirted bar (RANGE and FREQUENCY)	
	0370-0133	Knob: 5/8" skirted bar (AMPLITUDE)	
	03300-90000	Manual: operating and Service of Model 3300A serial prefixed 519	
	03300-00201	Panel: front Al	
	03300-00202	Panal: front sub	
	5000-0051	Plate: fluted Al	
	61B-40D-4	Plate: freq dial	
	5060-0766	Retainer: 5" handle assembly	
	5040-0607	Shaft: vernier disk	
	1490-0030	Stand: tilt stainless steel rod	
	03300-09101	Spring: vernier (bronze)	

Table 7-2. Replaceable Parts

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	RS
0121-0036	C: var 5. 5 pf to 18 pf	72982	538-006	1	1
0131-0004	C: var mica 16 - 150 pf 175 vdcw	72136	T51410-3	1	1
0140-0190	C: fxd mica 39 pf ±5%	00853	RDM1fE390J3C	1	1
0140-0191	C: fxd mica 56 pf ±5%	00853	RDM15E560J3C	1	1
0140-0197	C: fxd mica 180 pf ±5%	00853	RDM15F181J3C	1	1
0140-0198	C: fxd mica 200 pf ±5%	00853	RDM15F201J3C	3	3
0140-0200	C: fxd mica 390 pf ±5%	00853	RDM15F391J3C	1	1
0150-0012	C: fxd disc cer durez coated 0. 01 µf ±20% 100 vdcw	71590	13 C Disc obd#	2	1
0150-0093	C: fxd cer durez coated 0.01 µf+80%-20% 100 vdcw	91418	TA obd#	1	1
0150-0119	C: fxd 0. 01 2 section µf 250 vac	71590	DA17004CD	1	1
0160-0153	C: fxd 0. 001 µf ±10%	56289	192P10292	1	1
0160-0155	C: fxd 0. 0033 µf ±10%	56289	192P33292	2	1
0160-0195	C: fxd cer 1000 pf ±20% 250 vac	56289	19C251	1	1
0160-0356	C: fxd mica 18 pf ±5%	14655	RDM15C180J3C	1	1
0160-0376	C: fxd 68 pf ±5%	14655	RDM15E680J5C	1	1
0160-0859	C: fxd my 1 µf ±10% 50 vdcw	56289	148 P obd#	1	1
0160-0945	C: fxd mica 910 pf ±5%	00853	RDM15F911J1C	1	1
0160-2050	C: fxd my 10 µf ±10% 30 vdcw	56289	127P1069R354	1	1
0170-0022	C: fxd my 0. 1 µf ±10% 600 vdcw	56289	148P175A	2	1
0170-0029	C: fxd poly 0. 01 µf ±10% 50 vdcw	56289	P148073	1	1
0180-0056	C: fxd elect 1000 µf 50 vdcw	56289	D32429	2	1
0180-0149	C: fxd Al elect 65 µf +100%-10% 60 vdcw	56289	Type 30D obd#	4	1
0180-0161	C: fxd Ta elect 3. 3 µf ±20% 35 vdcw	05397	K3R3J35S	12	3
0370-0025	Knob: 3/4" diam (VERNIER)	28480	0370-0025	1	0
0370-0077	Knob: 5/8" skirted bar (RANGE and FUNCTION)	28480	0370-0077	3	0
0370-0133	Knob: 5/8" skirted bar (AMPLITUDE)	28480	0370-0133	2	0
0370-0160	Knob: dial round 1 5/8" diam black (DIAL)	28480	0370-0160	1	0
0683-0685	R: fxd comp 6. 8 ohms ±5% 1/4 w	01121	CB 0685	1	1
0683-1015	R: fxd comp 100 ohms ±5% 1/4 w	01121	CB 1015	1	1
0683-1025	R: fxd comp 1000 ohms ±5% 1/4 w	01121	CB 1025	1	1
0683-1035	R: fxd comp 10 K ±5% 1/4 w	01121	CB 1035	1	1
0683-1505	R: fxd comp 15 ohms ±5% 1/4 w	01121	CB 1505	1	1
0683-1535	R: fxd comp 15 K ±5% 1/4 w	01121	CB 1535	1	1
0683-1805	R: fxd comp 18 ohms ±5% 1/4 w	01121	CB 1805	1	1
0683-1825	R: fxd comp 1800 ohms ±5% 1/4 w	01121	CB 1825	1	1
0683-2025	R: fxd comp 2000 ohms ±5% 1/4 w	01121	CB 2025	7	2
0683-2415	R: fxd comp 240 ohms ±5% 1/4 w	01121	CB 2415	1	1
0683-2425	R: fxd comp 2400 ohms ±5% 1/4 w	01121	CB 2425	1	1
0683-3015	R: fxd comp 300 ohms ±5% 1/4 w	01121	CB 3015	1	1
0683-3035	R: fxd comp 30 K ±5% 1/4 w	01121	CB 3035	1	1
0683-3335	R: fxd comp 33 K ±5% 1/4 w	01121	CB 3335	1	1
0683-3625	R: fxd comp 3600 ohms ±5% 1/4 w	01121	CB 3625	4	1
0683-3925	R: fxd comp 3900 ohms ±5% 1/4 w	01121	CB 3925	2	1
0683-3935	R: fxd comp 39 K ±5% 1/4 w	01121	CB 3935	2	1
0683-4705	R: fxd comp 47 ohms ±5% 1/4 w	01121	CB 4705	3	1
0683-4735	R: fxd comp 47 K ±5% 1/4 w	01121	CB 4735	2	1
0683-5105	R: fxd comp 51 ohms ±5% 1/4 w	01121	CB 5105	1	1

Order by description

Table 7-2. Replaceable Parts (Cont'd)

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	RS
0683-5125	R: fxd comp 5100 ohms ±5% 1/4 w	01121	CB 5125	2	1
0683-6825	R: fxd comp 6800 ohms ±5% 1/4 w	01121	CB 6825	1	1
0683-8205	R: fxd comp 82 ohms ±5% 1/4 w	01121	CB 8205	1	1
0683-8215	R: fxd comp 820 ohms ±5% 1/4 w	01121	CB 8215	1	1
0683-8225	R: fxd comp 8200 ohms 1/4 w	01121	CB 8225	2	1
0686-2025	R: fxd comp 2000 ohms ±5% 1/2 w	01121	EB 2025	3	1
0686-2225	R: fxd comp 2200 ohms ±5% 1/2 w	01121	EB 2225	1	1
0686-5125	R: fxd comp 5100 ohms ±5% 1/4 w	01121	CB 5125	2	1
0686-6215	R: fxd comp 620 ohms ±5% 1/2 w	01121	EB 6215	4	1
0689-0275	R: fxd comp 2.7 ohms ±5% 1 w	01121	obd#	4	1
0698-0089	R: fxd prec met flm 1780 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3332	R: fxd prec met flm 80.6 ohms ±1% 1/2 w	75042	CEC T-O obd#	2	1
0698-3333	R: fxd prec met flm 137 ohms ±1% 1/2 w	75042	CEC T-O obd#	2	1
0698-3334	R: fxd prec met flm 178 ohms ±1% 1/2 w	75042	CEC T-O obd#	2	1
0698-3336	R: fxd prec met flm 475 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3337	R: fxd prec met flm 1370 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3338	R: fxd met oxide flm 1500 ohms ±5% 2 w	07115	C425 obd#	1	1
0698-3341	R: fxd prec met flm 1910 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3342	R: fxd prec met flm 2000 ohms ±1/4% 1/2 w	75042	CEC T-O obd#	2	1
0698-3347	R: fxd prec met flm 4530 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3348	R: fxd prec met flm 4640 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3349	R: fxd prec met flm 5760 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3350	R: fxd prec met flm 6650 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3352	R: fxd prec met flm 11.5 K ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3355	R: fxd prec met flm 1.5 meg ±1/4% 1/2 w	75042	CEC T-O obd#	1	1
0698-3413	R: fxd prec met flm 13.3 K ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3478	R: fxd prec met flm 806 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3480	R: fxd prec met flm 3740 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3481	R: fxd prec met flm 8060 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0698-3482	R: fxd prec 224 K ±1/4% 1/2 w	75042	CEC T-O obd#	2	1
0757-0041	R: fxd prec met flm 11.3 K ±1% 1/2 w	75042	CEC T-O obd#	1	1
0757-0066	R: fxd prec met flm 169 K ±1% 1/2 w	75042	CEC T-O obd#	1	1
0757-0085	R: fxd prec met flm 4020 ohms ±1% 1/2 w	75042	CEC T-O obd#	3	1
0757-0159	R: fxd prec met flm 1000 ohms ±1% 1/2 w	19701	MF7C T-O obd#	7	2
0757-0178	R: fxd prec met flm 100 ohms ±1% 1/4 w	19701	MF6C T-O obd#	1	1
0757-0190	R: fxd prec met flm 20 K ±1% 1/2 w	19701	MF7C T-O obd#	2	1
0757-0283	R: fxd prec met flm 5110 ohms ±1% 1/8 w	19701	MF5C T-O obd#	3	1
0757-0442	R: fxd prec met flm 10 K ±1% 1/8 w	75042	CEA T-O obd#	2	1
0757-0812	R: fxd prec met flm 432 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0757-0817	R: fxd prec met flm 750 ohms ±1% 1/2 w	75042	CEC T-O obd#	2	1
0757-0819	R: fxd prec met flm 909 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0757-0821	R: fxd prec met flm 210 ohms ±1% 1/2 w	75042	CEC T-O obd#	2	1
0757-0824	R: fxd prec met flm 2000 ohms ±1% 1/2 w	75042	CEC T-O obd#	3	1
0757-0828	R: fxd prec met flm 2010 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0757-0830	R: fxd prec met flm 3920 ohms ±1% 1/2 w	75042	CEC T-O obd#	1	1
0757-0832	R: fxd prec met flm 4750 ohms ±1% 1/2 w	75042	CEC T-O obd#	3	1
0757-1000	R: fxd prec met flm 51.1 ohms ±1% 1/2 w	75042	CEC T-O obd#	2	1
0757-1085	R: fxd prec met flm 21 K ±1% 1/2 w	75042	CEC T-O obd#	1	1

Order by description

Table 7-2. Replaceable Parts (Cont'd)

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	RS
0757-1091	R: fxd prec met flm 280 ohms ±1% 1/2 w	75042	CEC T-O obd#	2	1
0761-0009	R: fxd met oxide flm 1200 ohms ±5% 1w	07115	C32 obd#	1	1
0761-0057	R: fxd met oxide flm 560 ohms ±5% 1 w	07115	C32 obd#	1	1
0764-0024	R: fxd met oxide flm 430 ohms ±5% 1/2 w	07115	C425	1	1
0766-0025	R: fxd met flm 101 ohms ±2% 3 w	76055	3MOL obd#	6	2
0811-1546	R: fxd prec ww 374 ohms ±1/4% 1/3 w	15909	DAX1 obd#	2	1
0811-1547	R: fxd prec ww 1740 ohms ±1/4% 1/3 w	15909	DAX1 obd#	1	1
0811-1548	R: fxd prec 2260 ohms ±1/4% 1/3 w	15909	DAX1 obd#	2	1
0811-1549	R: fxd prec ww 3320 ohms ±1/4% 1/3 w	15909	DAX1 obd#	2	1
0811-1550	R: fxd prec ww 16. 5 K ±1/4% 2/3 w	15909	DAX2 obd#	1	1
0839-0012	Thermistor: 50 K ±10%	83186	45R1 obd#	1	1
1205-0033	Heat dissipator semi-conductor	05820	NF-207 obd#	4	1
1250-0118	Connector: BNC UG-1094 A/U	91737	8427	4	1
1251-0101	Connector: 50 Pin	71785	57-20500-375	1	0
1251-0159	Connector: 30 pin double readout	75173	251-15-30-261	4	0
1251-0208	Connector: 22 pin pc (fork type contacts)	02660	143-022-08 (109)	1	0
1251-1009	Connector: ac power cord receptacle	82389	AC-3 obd#	1	0
1400-0084	Fuse holder: extractor post type black bakelite	75915	342014	1	1
1490-0030	Stand: tilt stainless steel rod	91260	obd#	1	0
1853-0001	Transistor: Si PNP **	28480	1853-0001	1	1
1853-0009	Transistor: Si PNP **	28480	1853-0009	11	4
1853-0010	Transistor: Si PNP **	28480	1853-0010	1	1
1853-0016	Transistor: Si PNP 2N3638	72354	2N3638	1	1
1854-0003	Transistor: Si NPN **	28480	1854-0003	1	1
1854-0005	Transistor: Si NPN 2N708	01295	2N798	3	1
1854-0033	Transistor: Si NPN 2N3391	24446	2N3391	9	3
1854-0039	Transistor: Si NPN 2N3053	86684	2N3053	12	4
1854-0072	Transistor: Si NPN 2N3054	86684	2N3054	2	1
1854-0081	Transistor: Si NPN **	28480	1854-0081	4	2
1901-0025	Diode: Si junction 100 ma at 1 v 100 piv 12 pf	93332	D 3072	13	4
1901-0026	Diode: Si 200 piv	11711	obd#	4	2
1901-0033	Diode: Si 100 ma at + 1 v 180 wiv 13 pf	93332	D 6238	1	1
1901-0040	Diode: Si 30 ma at + 1 v 30 piv 2 pf 2 ns	03877	SG 5050	18	6
1902-3182	Diode: breakdown zener 12. 1 v ±5% 400 mw	04713	SZ10930-206	1	1
2100-0118	R: var lin 100 ohms ±20% 3/10 w	71450	Type 70 obd#	1	1
2100-0136	R: var lin 6000 ohms ±20% 3/10 w	71450	Series 70 obd#	1	1
2100-0261	R: var lin 2000 ohms ±20% 3/10 w	71450	Series 70 obd#	1	1
2100-0299	R: var lin 2000 ohms ±20% 3/10 w	71450	Series 70 obd#	1	1
2100-0809	R: var lin 250 ohms ±30% 3/10 w	71450	Series 70 obd#	1	1
2100-0856	R: var lin 350 ohms ±30% 1/8 w	11236	XQS-200 obd#	2	1
2100-0865	R: var comp lin 350 ohms ±30% 1/8 w	71450	XQS-200 obd#	3	1
2100-1434	R: var pot comp lin 1000 ohms ±30% 1/8 w	71450	XQS-200 obd#	2	1
2100-1548	R: var comp molded C attenuator 600 ohms ±20% 5 w	12697	53M obd#	2	1
2100-1563	R: var ww lin freq control 1000 ohms ±5% 3 w	12697	Series 42 obd#	1	1
2110-0007	Fuse: cartridge slow blow 1 amp 125 v	75915	313001	1	10
2950-0039	Extension: nut hexagonal 9/16"	28480	2950-0039	1	0
3101-0033	Switch: slide DPDT non-shorting 0. 5 amp 125 vdc 3 amp 125 vac	79727	G-326;6510 Rev A	1	0
3101-0100	Switch: pushbutton lighted SPDT 2 amp at 125 vacw	87034	SW-624-109	1	1

Order by description

Table 7-2. Replaceable Parts (Cont'd)

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	RS
3050-0159	Washer: insulated #6 nylon	28480	3050-0159	2	0
3100-1709	Switch: rotary (RANGE)	76854	Type F obd#	1	1
3100-1710	Switch: rotary (function CHANNEL A)	76854	obd#	1	1
3100-1711	Switch: rotary (function CHANNEL B)	76854	obd#	1	1
5000-0051	Plate: fluted Al	28480	5000-0051	2	0
5000-0732	Cover: rear side	28480	5000-0732	2	0
5000-0733	Cover: front side	28480	5000-0733	2	0
5020-0630	Dial: hub	28480	5020-0630	1	0
5040-0607	Shaft: vernier disk	28480	5040-0607	1	0
5040-0619	Insulator: panel connector	28480	5040-0619	1	0
5060-0222	Handle: side assembly	28480	5060-0222	2	0
5060-0739	Cover: top assembly	28480	5060-0739	1	0
5060-0751	Cover: bottom assembly	28480	5060-0751	1	0
5060-0766	Retainer: 5 H handle assembly	28480	5060-0766	2	0
5060-0767	Foot assembly	28480	5060-0767	5	1
5060-0775	Accessory: 5" rack mount kit	28480	5060-0775	1	0
8120-0078	Cable assembly: ac power cord 7. 5 feet long	70903	KH-4147	1	1
9100-1306	Transformer: power	28480	9100-1306	1	1
03300-00201	Panel: front Al	28480	03300-00201	1	0
03300-00202	Panel: front sub	28480	03300-00202	1	0
03300-00605	Cover: chassis bottom	28480	03300-00605	2	0
03300-00606	Cover: panel rear	28480	03300-00606	1	0
03300-00607	Cover: chassis top	28480	03300-00607	1	0
03300-04001	Dial: frequency	28480	03300-04001	1	1
03300-09101	Spring: vernier (bronze)	28480	03300-09101	1	0
03300-46902	Oven assembly	28480	03300-46902	1	1
03300-46904	Cover: oven	28480	03300-46904	1	0
03300-66501	Oven board assembly	28480	03300-66501	1	0
03300-66502	Power supply board assembly	28480	03300-66502	1	0
03300-66503	Integrator board assembly	28480	03300-66503	1	0
03300-66504	Shaper comparator board assembly	28480	03300-66504	1	0
03300-66505	Amplifier board assembly	28480	03300-66505	2	0
03300-90000	Manual: operating and service of -hp- Model 3300A	28480	03300-90000	1	1

Order by description

Manufacturer's Code

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00334	Humidail Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc., Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04777	Automatic Electric Sales Corp.	Northlake, Ill.
04796	Sequoia Wire & Cable Co.	Redwood City, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metropolitan Telecommunications Corp., Metro Cap. Division	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	U. S. Semcor Division of Nuclear Corp. of America	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co., Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09664	The Bristol Co.	Waterbury, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermolloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth 1, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
71707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen-Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co, Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	So. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostran Instrument and Electronic Co.	South Pasadena, Calif.
77250	Phoell Mfg. Co.	Chicago, Ill.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association. Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81349	Military Specification	.....
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.

From: F.S.C. Handbook Supplements
H4-1 Dated March 1963
H4-2 Dated March 1962

Manufacturer's Code (cont'd)

Code No.	Manufacturer	Address
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronis, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Inc. Co.	Oakland, Calif.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
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92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
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93369	Robbins and Myers, Inc.	New York, N.Y.
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93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94222	Southco Div. of S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
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99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
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99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.

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G0000	Tranex Company	Mountain View, Calif.
I0000	Western Devices, Inc.	Inglewood, Calif.
J0000	Winchester Electronics, Inc.	Santa Monica, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000O	U.S.A. Common	Any supplier of U.S.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
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000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
000II	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics	Sun Valley, Calif.
000QQ	Cooltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000WW	California Eastern Lab.	Burlingame, Calif.
000XX	Methode Electronics, Inc.	Chicago 31, Ill.
000YY	S.K. Smith Co.	Los Angeles 45, Calif.

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